Verso: The Sovereign Enterprise Operating System

Complete Technical Reference & Feature Specification

A Declaration of Independence from Silicon Valley

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Version 2.1 — Comprehensive Edition

Abstract

The modern enterprise has surrendered its operational sovereignty to a constellation of SaaS platforms that fragment data ownership, impose unsustainable per-seat pricing, and create existential platform dependency. Verso is a comprehensive rejection of this model—a **Sovereign Enterprise Operating System** designed to run on commodity infrastructure while providing a complete suite of business tools. This comprehensive whitepaper documents every feature, capability, and architectural decision in Verso 2.1, serving as a complete technical reference for the platform's **120+ database models**, **45 route modules**, **35 helper modules**, and **44 React components** spanning CRM, E-commerce, Communications, Analytics, Scheduling, Content Management, HR, Compliance, and AI-assisted operations.

Contents

1 Executive Summary

Verso consolidates the functionality of 15+ enterprise SaaS products into a single, self-hosted application:

SaaS Category	Verso Equivalent
Auth0 / Clerk	Identity & MFA System
Shopify Plus	Complete E-commerce Platform
Salesforce / HubSpot	CRM & Lead Management
Calendly / Acuity	Scheduling & Booking
Mailchimp / Klaviyo	Email Marketing & Drip Campaigns
Contentful / Sanity	Blog & CMS
Mixpanel / Amplitude	Sovereign Analytics
Slack / Teams	Internal Messaging
Typeform / JotForm	Dynamic Forms & Surveys
Delighted / SurveyMonkey	NPS/CSAT Surveys
Zendesk	Customer Reviews & Feedback
Gusto / BambooHR	Employee Portal & HR
OneSignal	Push Notifications
Twilio	SMS Messaging
Stripe Billing	Subscriptions & Payments

Table 1: SaaS Replacement Matrix

1.1 Platform Statistics

- **Database Models**: 120+ SQLAlchemy models across 4,335 lines
- **Route Modules**: 45 Flask blueprints totaling 500+ endpoints
- **Helper Modules**: 35 business logic modules
- **React Components**: 44 TypeScript components
- **Templates**: 200+ Jinja2 templates
- **Lines of Code**: 50,000+ (Python, TypeScript, HTML, CSS)

2 Philosophy: The Four Pillars

2.1 Sovereignty

Complete ownership of code and data. Every record, file, and configuration exists in databases and filesystems under your control. Core functionality requires zero external API calls. Stripe integration for payments is the only external dependency—and even that is abstracted for future payment provider flexibility.

2.2 Simplicity

A rejection of "Resume Driven Development." Verso uses proven, battle-tested technologies:

- **Python 3.10+**: Readable, maintainable, well-understood
- **Flask**: Micro-framework with explicit control
- **SQLAlchemy 2.0**: Industry-standard ORM with raw SQL escape hatch
- **PostgreSQL/SQLite**: ACID-compliant, battle-tested databases
- **Server-rendered HTML**: Zero hydration, instant interactivity
- **React Islands**: Strategic interactivity where needed

2.3 Frugality

Designed to run on $20/month infrastructure. No required Redis. No Elasticsearch cluster. No S3 bucket dependencies. No Kubernetes orchestration. A single VPS with 2GB RAM runs the entire system at meaningful scale.

2.4 Resilience

Offline-first design principles. Database-backed task queues eliminate Redis dependency for background processing. Self-contained deployment with single-file database backups. The entire business state can be restored from one SQL dump.

3 Technical Architecture

3.1 Application Factory Pattern

Verso uses Flask's application factory pattern for testability and configuration flexibility:

```python
def create_app(config_class=Config):
    app = Flask(__name__)
    app.config.from_object(config_class)

    # Initialize extensions
    db.init_app(app)
    migrate.init_app(app, db)
    login_manager.init_app(app)
    mail.init_app(app)
    cache.init_app(app)
    babel.init_app(app)

    # Register 45+ blueprints
    app.register_blueprint(auth_bp)
    app.register_blueprint(admin_bp, url_prefix='/admin')
    app.register_blueprint(shop_bp)
    # ...

    return app
```

3.2 Complete Blueprint Registry

Blueprint	Prefix	Purpose
admin	/admin	Admin dashboard, users, roles, config
ai	/ai	AI-powered features
analytics	/analytics	Traffic & conversion tracking
api	/api/v1	REST API endpoints
api_docs	/api/docs	OpenAPI documentation
auth	/auth	Login, register, password reset, OAuth
automation	/automation	Workflow automation
availability	/availability	Staff availability management
backup	/backup	Database backup & restore
blog	/blog	Blog posts, categories, comments
booking_api	/booking	Booking REST API
calendar	/calendar	FullCalendar integration

Blueprint	Prefix	Purpose
cart	/cart	Shopping cart operations
category_admin	/admin/categories	Product category management
crm	/crm	Lead management, pipelines
ecommerce	/shop	Public storefront
ecommerce_admin	/admin/shop	E-commerce administration
email_admin	/admin/email	Email templates & campaigns
email_tracking	/t	Email open/click tracking
employee	/employee	Employee portal
forms	/forms	Public form submissions
forms_admin	/admin/forms	Form builder & surveys
main_routes	/	Homepage, contact, about
media	/media	Media file serving
messaging	/messaging	Internal chat
newsletter	/newsletter	Newsletter management
notifications	/notifications	Notification center
oauth	/oauth	Social login callbacks
observability	/observability	Metrics & health checks
onboarding	/onboarding	User onboarding flow
orders_admin	/admin/orders	Order management
pages	/p	Dynamic pages
privacy	/privacy	GDPR data export/deletion
push	/push	Web push notifications
reports	/reports	Report generation
scheduling	/schedule	Appointment booking
setup	/setup	Initial setup wizard
shop	/shop	Product catalog
shop_admin	/admin/products	Product management
subscriptions	/subscriptions	Stripe subscriptions
tasks_admin	/admin/tasks	Background task management
theme	/theme	Theme customization
user	/user	User profile & settings
webhooks	/webhooks	Outbound webhooks

Table 2: Complete Blueprint Registry (45 modules)

3.3 Database Schema Overview

The database contains **120+ models** organized across functional domains:

Domain	Models
Identity & Auth	User, Role, user_roles, TOTPDevice, BackupCode, UserMFA, MFAChallenge, LoginAttempt, PasswordHistory, IPBlacklist
User Experience	UserPreference, UserActivity, OnboardingStep, SavedItem, NotificationPreference

Domain	Models
E-commerce Core	Product, ProductVariant, ProductImage, ProductAttribute, ProductAttributeValue, ProductAttributeAssignment, Category, Collection, CollectionRule, CollectionProduct
E-commerce Orders	Order, OrderItem, UserCart, InventoryLock, DownloadToken, DownloadLog
Pricing & Promotions	Discount, DiscountRule, DiscountUsage, GiftCard, GiftCardTransaction, ProductBundle, BundleItem
Shipping & Tax	ShippingZone, ShippingRate, TaxRate
Customer Engagement	Wishlist, RecentlyViewed, RelatedProduct, Review, ReviewVote
Subscriptions	Subscription (Stripe integration)
Content Management	Post, PostRevision, PostImage, PostView, Tag, post_tags, BlogCategory, PostSeries, Comment, Page, PageRevision, PageCustomField, PageRender, Media
Scheduling	Appointment, AppointmentType, AppointmentAttendee, Availability, AvailabilityException, Resource, ResourceBooking, Waitlist, BookingPolicy, CheckInToken, RescheduleRequest, Service, Estimator
CRM & Leads	ContactFormSubmission, PipelineStage, LeadNote, LeadActivity, LeadScore, LeadScoreRule, FollowUpReminder
Communications	Channel, Message, ChannelMember, MessageReaction, Notification, EmailTemplate, EmailCampaign, EmailSend, EmailClickTrack, DripSequence, SequenceEnrollment, PushSubscription, SMSTemplate, SMSConsent, EmailSuppressionList, Audience, AudienceMember
Forms & Surveys	FormDefinition, FormSubmission, FormIntegration, Survey, SurveyResponse
Analytics	PageView, VisitorSession, ConversionGoal, Conversion, Funnel, FunnelStep, SavedReport, ReportExport
HR & Employee	LeaveRequest, LeaveType, LeaveBalance, TimeEntry, EncryptedDocument, DocumentShare
Operations	Task, CronTask, WorkerHeartbeat, AuditLog, Location, ApiKey, Newsletter, UnsubscribedEmail, BusinessConfig
Automation	Workflow, WorkflowStep, Webhook, WebhookDelivery
Infrastructure	Backup, BackupSchedule, FeatureFlag, DeploymentLog
Compliance	ConsentRecord, DataExportRequest, RetentionPolicy, DataRetentionLog

Table 3: Complete Data Model Registry (120+ models)

4 Identity & Access Management

4.1 User Model

The User model is the central identity entity with 30+ fields:

- **Core Identity**: username, email, password_hash, first_name, last_name
- **Profile**: bio, skills, phone, timezone, avatar_url, profile_photo
- **Employment**: job_title, department, reports_to_id, location_id
- **OAuth**: oauth_provider (google/apple/microsoft), oauth_id
- **Verification**: confirmed, email_verified, email_verification_token
- **Onboarding**: onboarding_completed, profile_completion_score
- **Activity**: last_activity_at, date (registration)
- **Emergency**: emergency_contacts (JSON)

4.2 Role-Based Access Control

Default roles with hierarchical permissions:

- **admin**: Full system access
- **commercial**: Sales/CRM access
- **blogger**: Content creation access
- **employee**: Employee portal access
- **user**: Standard user access

4.3 Multi-Factor Authentication

Complete MFA implementation:

- **TOTP**: Time-based One-Time Passwords (Google Authenticator compatible)
- **Backup Codes**: One-time recovery codes
- **SMS/Email**: Secondary verification channels
- **Challenge Tracking**: MFAChallenge model with attempt limits and expiration
- **Password History**: Prevent password reuse (configurable depth)

4.4 OAuth Integration

Social login support:

- Google Sign-In
- Apple Sign-In
- Microsoft Account

4.5 Security Features

- **Login Attempt Tracking**: LoginAttempt model with IP, user agent, location, device fingerprint
- **IP Blacklisting**: Automatic and manual IP blocking with expiration
- **Progressive Delays**: Exponential backoff on failed logins
- **Session Management**: Concurrent session tracking with forced logout capability
- **Password Policies**: Configurable strength requirements

5 E-Commerce Platform

A complete e-commerce solution rivaling Shopify Plus—without the platform fees.

5.1 Product Management

5.1.1 Core Product Model

- name, description, price (cents), currency
- inventory_count with stock tracking
- is_digital flag with file_id for digital goods
- is_subscription with stripe_price_id for recurring billing
- category_id for hierarchical organization
- media_id for primary image
- location_id for multi-location inventory

5.1.2 Product Variants

Full variant support with SKU-level inventory:

- sku (unique identifier)
- name (e.g., "Large / Blue")
- price_adjustment (cents added/subtracted from base)
- inventory_count per variant
- attributes (JSON: {"size": "L", "color": "Blue"})
- is_active toggle

5.1.3 Product Attributes

Reusable attribute system:

- **ProductAttribute**: Size, Color, Material definitions
- **ProductAttributeValue**: S, M, L, XL with color swatches
- **ProductAttributeAssignment**: Link attributes to products
- Attribute types: select, color, size, text

5.1.4 Product Images

Multi-image galleries:

- Multiple images per product with positioning
- is_primary flag for main image
- variant_id for variant-specific images
- image_type: photo, lifestyle, diagram
- alt_text for accessibility/SEO

5.2 Collections

Smart and manual product groupings:

- **Manual Collections**: Curated product lists with ordering
- **Smart Collections**: Rule-based auto-population
- Collection rules: category, tag, price range, in_stock
- Sort options: manual, best_selling, newest, price_asc/desc, alpha
- SEO fields: seo_title, seo_description
- Scheduling: starts_at, ends_at for seasonal collections
- show_on_homepage toggle

5.3 Product Bundles

Bundle pricing with automatic savings:

- Fixed bundle price OR percentage/fixed discount
- BundleItem model for included products
- Optional items with is_default_selected
- Automatic savings calculation
- Date-based activation (starts_at, ends_at)

5.4 Discount System

Comprehensive coupon and automatic discount engine:

5.4.1 Discount Types

- **percentage**: X% off order
- **fixed_amount**: $X off order
- **buy_x_get_y**: BOGO promotions
- **free_shipping**: Waive shipping costs

5.4.2 Discount Features

- Coupon codes OR automatic application
- minimum_order_cents requirement
- maximum_discount_cents cap
- maximum_uses total limit
- usage_limit_per_customer
- applies_to: all, specific_products, specific_collections
- Date scheduling: starts_at, ends_at
- customer_eligibility: all, new_customers, returning_customers
- combine_with_other_discounts flag
- DiscountRule conditions for complex logic
- DiscountUsage tracking per order/user

5.5 Gift Cards

Full gift card lifecycle management:

- Unique codes with balance tracking
- initial_balance_cents and current_balance_cents
- Expiration dates
- Recipient info: email, name, sender_name, message
- Purchase tracking (purchased_order_id)
- GiftCardTransaction history: purchase, redemption, refund, adjustment
- Delivery tracking (delivered_at)

5.6 Shipping

Zone-based shipping with multiple rate types:

5.6.1 ShippingZone

- countries (JSON list of ISO codes)
- states (JSON list of state codes)
- zip_codes for granular targeting
- is_rest_of_world fallback zone

5.6.2 ShippingRate

- rate_type: flat, weight_based, price_based, free
- price_cents and price_per_kg_cents
- Weight/price thresholds (min/max)
- free_shipping_threshold_cents
- estimated_days_min/max for delivery estimates

5.7 Tax

Jurisdiction-based tax calculation:

- Rate by country, state, zip_code
- tax_type: sales, vat, gst
- applies_to_shipping flag
- is_compound for tax-on-tax
- priority for application order

5.8 Orders

Complete order management:

- status: pending, paid, shipped, cancelled
- fulfillment_status: unfulfilled, shipped, delivered, returned
- Tracking: tracking_number, carrier, shipped_at, delivered_at
- stripe_payment_intent_id for payment tracking
- shipping_address (JSON)
- Guest checkout support (email without user_id)
- OrderItem with price_at_purchase for historical accuracy

5.9 Digital Products

Secure digital delivery:

- **DownloadToken**: Unique tokens with max_downloads and expiration
- **DownloadLog**: Track all download attempts with IP, user agent

5.10 Subscriptions

Stripe subscription integration:

- stripe_subscription_id and stripe_customer_id
- status: active, past_due, canceled, trialing
- current_period_start/end
- cancel_at_period_end flag

5.11 Customer Engagement

- **Wishlist**: Save products/variants for later
- **RecentlyViewed**: Track browsing history per user/session
- **RelatedProduct**: Cross-sell, up-sell, accessory, frequently_bought_together

5.12 Reviews

Product review system with moderation:

- 1-5 star rating with title and body
- status: pending, approved, rejected
- verified_purchase flag (linked to order)
- helpful_count / not_helpful_count voting
- Owner/admin response capability
- Image attachments (JSON)
- ReviewVote for helpful/not helpful tracking

6 Scheduling & Calendar

FullCalendar-powered scheduling with UTC-safe time handling.

6.1 Appointment Types

Configurable booking types:

- duration_minutes, buffer_before, buffer_after
- price (optional)
- color for calendar display
- max_per_day per staff limit
- max_attendees for group appointments
- booking_window_days (how far in advance)
- min_notice_hours (minimum booking notice)
- required_resource_type for auto-booking rooms/equipment
- intake_form_id for pre-appointment data collection

6.2 Staff Availability

- **Availability**: Weekly recurring slots (day_of_week, start_time, end_time)
- **AvailabilityException**: Holidays, PTO, custom hours
- is_blocked for full days off
- custom_start_time/end_time for modified hours
- reason field ("Holiday", "PTO")

6.3 Resources

Physical resource booking:

- resource_type: room, equipment, vehicle
- capacity for occupancy limits
- amenities (JSON list)
- hourly_rate for billing
- **ResourceBooking**: Time slot reservations linked to appointments

6.4 Waitlist

Queue management for popular slots:

- preferred_date, preferred_time_range (morning/afternoon/evening)
- preferred_staff_id
- status: waiting, offered, booked, expired, cancelled
- priority for VIP handling
- Offer expiration (offer_expires_at)

6.5 Booking Policies

Per-type policies:

- Cancellation: cancellation_hours, cancellation_fee
- No-show: no_show_fee, no_show_penalty_type (none/fee/block)
- Deposits: deposit_required, deposit_amount/percentage
- Reschedule: max_reschedules, reschedule_hours
- Reminders: reminder_1/2/3_hours, send_confirmation, send_reminders

6.6 Group Appointments

- **AppointmentAttendee**: Multiple attendees per appointment
- Individual check-in tracking
- Status per attendee: confirmed, cancelled, no_show

6.7 QR Check-In

- **CheckInToken**: Unique QR codes per appointment
- Token expiration
- checked_in_method: qr, manual

6.8 Reschedule Workflow

- **RescheduleRequest**: Staff-initiated proposals
- proposed_datetime, reason
- status: pending, approved, rejected
- admin_notes for decisions

7 CRM & Lead Management

Integrated customer relationship management.

7.1 Pipeline Stages

Kanban-style lead tracking:

- Customizable stages with ordering
- color for visual distinction
- probability (0-100%) for forecasting
- auto_actions for workflow triggers
- is_won_stage / is_lost_stage flags
- Multi-pipeline support (pipeline_name)

7.2 Lead Sources

ContactFormSubmission with enriched tracking:

- source: contact_form, referral, website, etc.
- assigned_to_id for rep assignment
- custom_fields (JSON) for dynamic data
- tags (JSON) for categorization
- location_id for multi-location tracking

7.3 Lead Scoring

ML-assisted qualification:

- **LeadScore**: Total score with breakdown (JSON)
- **LeadScoreRule**: Configurable scoring rules
- Categories: source, engagement, fit, behavior
- Condition types: source_equals, has_phone, message_length_gt, etc.

7.4 Activity Timeline

Complete interaction history:

- **LeadNote**: Manual notes with pinning
- **LeadActivity**: Auto-logged events (status_change, email_sent, note_added)
- old_value / new_value for change tracking
- extra_data (JSON) for context

7.5 Follow-Up Reminders

Stale lead prevention:

- due_date with status tracking
- Assignment to specific users
- status: pending, completed, dismissed

8 Communication Hub

Unified internal and customer communication.

8.1 Messaging

Slack-like internal communication:

- **Channel**: Public, private, or direct message
- is_archived, is_direct flags
- description for channel context
- **Message**: Content with optional attachments
- Thread support (parent_id)
- @mention extraction
- **ChannelMember**: Membership with read receipts (last_read_message_id)
- is_muted for notification control
- **MessageReaction**: Emoji reactions on messages

8.2 Email Marketing

Complete campaign management:

8.2.1 Email Templates

- subject, body_html, body_text
- template_type: general, welcome, follow_up, marketing, transactional
- category for organization
- variables_schema (JSON) with defaults
- Template rendering with variable substitution

8.2.2 Audiences

Dynamic or static segmentation:

- **Audience**: Segment definitions
- is_dynamic for rule-based recalculation
- filter_rules (JSON) for dynamic audiences
- **AudienceMember**: Static membership
- member_count caching

8.2.3 Email Campaigns

- template_id, audience_id linking
- status: draft, scheduled, sending, sent, paused, cancelled
- Scheduling (scheduled_at, sent_at, completed_at)
- A/B testing: subject_line_a/b, ab_test_percentage
- Stats: sent/delivered/open/click/unsubscribe/bounce/complaint counts
- Open rate and click rate calculations

8.2.4 Email Tracking

Privacy-respecting engagement tracking:

- **EmailSend**: Individual send records
- tracking_token for pixel/link tracking
- Timestamps: sent_at, delivered_at, first/last_opened_at, first_clicked_at
- Engagement counts: open_count, click_count
- Status flags: bounced, bounce_type/reason, unsubscribed, complained
- **EmailClickTrack**: Detailed link analytics

8.3 Drip Sequences

Automated email sequences:

- **DripSequence**: Sequence definitions
- trigger_event: user_signup, order_placed, form_submit, manual
- steps_config (JSON) with template and delay
- **SequenceEnrollment**: User progress tracking
- current_step, next_step_at
- status: active, paused, completed, unsubscribed
- context_data for personalization

8.4 Push Notifications

Web push with VAPID:

- **PushSubscription**: Subscription data
- endpoint, p256dh_key, auth_key
- device_name for user identification
- categories (JSON) for notification preferences
- pywebpush integration

8.5 SMS

TCPA-compliant SMS messaging:

- **SMSTemplate**: Message templates with segment calculation
- **SMSConsent**: Consent tracking
- consent_source, consent_text, ip_address
- categories: transactional, marketing, reminders
- Revocation support

8.6 Suppression

Email deliverability management:

- **EmailSuppressionList**: Global suppression
- reason: hard_bounce, unsubscribe, complaint
- source tracking
- **UnsubscribedEmail**: Newsletter opt-outs

8.7 Notifications

Unified notification system:

- **Notification**: All app events
- type: message, leave_approved, appointment_reminder, order_placed, mention
- title, body, link
- related_type/id for navigation
- email_sent for digest tracking
- **NotificationPreference**: User settings
- email_digest_enabled/frequency
- muted_types (JSON)

9 Content Management System

First-party blog and page management.

9.1 Blog

9.1.1 Posts

- title, slug, content (CKEditor HTML)
- blog_category_id for categorization
- tags (many-to-many with Tag model)
- is_featured flag
- series_id, series_order for multi-part content

- publish_at for scheduled publishing
- meta_description for SEO
- read_time_minutes (auto-calculated)
- is_published toggle
- Hero image (BLOB) with MIME type
- additional_authors for multi-author posts

9.1.2 Categories & Tags

- **BlogCategory**: Hierarchical categories (parent_id)
- **Tag**: Many-to-many tagging
- Slug-based URLs
- Breadcrumb generation (get_ancestors)

9.1.3 Series

- **PostSeries**: Group related posts
- title, description, slug
- series_order on posts

9.1.4 Comments

- Threaded comments (parent_id)
- Registered user or guest (author_name, author_email)
- status: pending, approved, spam, rejected
- ip_hash for abuse prevention

9.1.5 Revisions

Full version control:

- **PostRevision**: Complete content snapshots
- revision_note for change descriptions
- User attribution

9.1.6 Analytics

- **PostView**: Deduplicated view tracking
- session_id, user_id, ip_hash
- referrer tracking

9.2 Pages

Static pages with staging workflow:

- status: draft, review, published
- html_content (CKEditor)
- meta_description, canonical_url
- schema_type: WebPage, AboutPage, ContactPage, FAQPage
- author_id for attribution
- **PageRevision**: Version history
- **PageCustomField**: Flexible key-value fields
- field_type: text, number, date, boolean, json
- **PageRender**: Pre-rendered HTML cache

9.3 Media

File management:

- filename, data (BLOB), mimetype, size
- checksum for deduplication
- uploaded_by_id for attribution

10 Forms & Data Collection

Dynamic form builder with integrations.

10.1 Form Definitions

- fields_schema (JSON) with field definitions
- Field types: text, email, phone, textarea, select, checkbox, radio, file
- Validation rules per field
- settings (JSON): submit_text, success_message, redirect_url, honeypot, rate_limit
- Multi-page support (is_multi_page, page_config)
- Conditional logic (JSON) for field visibility
- submissions_count caching

10.2 Form Submissions

- data (JSON) storage
- Tracking: ip_address, user_agent, referrer
- utm_params for source attribution
- status: new, read, processed, archived
- Spam detection: is_spam, spam_score
- File attachments (JSON)

10.3 Form Integrations

Post-submission automation:

- integration_type: webhook, crm_lead, email_list, email_notify, slack
- config (JSON) per type
- field_mapping for data transformation
- Trigger tracking: last_triggered_at, trigger_count, last_error

10.4 Surveys

NPS, CSAT, CES, and custom surveys:

- survey_type: nps, csat, ces, custom
- questions_schema (JSON) with question definitions
- trigger_event: order_complete, appointment_complete, manual
- trigger_delay_hours
- display_mode: page, embed, modal
- thank_you_message, redirect_url
- NPS calculation method

10.5 Survey Responses

- responses (JSON) for answers
- score for primary metric
- nps_category: promoter, passive, detractor
- context_type/id for linking to orders, appointments

11 Analytics & Reporting

Built-in analytics with no external dependencies.

11.1 Page Tracking

- **PageView**: Individual page views
- session_id for visitor sessions
- UTM tracking: source, medium, campaign, term, content
- Device intelligence: device_type, browser, os (parsed from user_agent)
- load_time_ms for performance monitoring
- ip_hash for privacy-respecting tracking

11.2 Visitor Sessions

- **VisitorSession**: Complete session tracking
- entry_page, exit_page
- pages_viewed, duration_seconds
- bounce detection
- Source tracking with UTM params
- Device and location info

11.3 Conversion Tracking

- **ConversionGoal**: Goal definitions
- goal_type: page_visit, form_submit, purchase, signup, custom
- target_path for URL matching
- target_value for monetary goals
- count_once_per_session option
- **Conversion**: Individual conversion events
- First/last touch attribution

11.4 Funnels

- **Funnel**: Funnel definitions
- **FunnelStep**: Steps linked to conversion goals
- Conversion rate calculations between steps
- Drop-off analysis

11.5 Report Builder

- **SavedReport**: Custom report configurations
- report_type: revenue, products, customers, traffic, custom
- config_json for filters, groupings, date ranges
- Scheduling: schedule_cron, last_run_at, next_run_at
- is_public for sharing

- **ReportExport**: Generated exports
- format: csv, pdf, xlsx
- Expiration and download tracking

12   HR & Employee Portal

12.1   Leave Management

- **LeaveRequest**: Leave applications
- leave_type: vacation, sick, personal, unpaid
- status: pending, approved, rejected
- Approval workflow with approved_by_id, admin_notes
- **LeaveType**: Configurable policies
- default_days_per_year
- Carryover: allows_carryover, max_carryover_days
- is_paid, requires_approval flags
- **LeaveBalance**: Per-user annual entitlements
- balance_days, used_days, carryover_days

12.2   Time Tracking

- **TimeEntry**: Clock in/out
- clock_in, clock_out timestamps
- duration_minutes (auto-calculated)
- notes for context

12.3   Document Management

- **EncryptedDocument**: Secure storage
- blob_data (encrypted content)
- category: contracts, certifications, personal
- expires_at for certifications/licenses
- Signature support: requires_signature, signed_by_id, signed_at
- **DocumentShare**: Sharing between users/roles
- permissions: view, download

12.4   Employee Profile

User model extensions:

- job_title, department
- reports_to_id (org chart)
- profile_photo_id
- direct_reports relationship

13   Automation & Workflows

13.1   Workflow Engine

- **Workflow**: Automation definitions
- trigger_event: lead.created, order.created, etc.
- is_active toggle
- **WorkflowStep**: Sequential actions

- action_type: send_email, create_task, update_field, webhook
- config (JSON) for action parameters
- Ordered execution

13.2 Webhooks

Outbound integrations:

- **Webhook**: Endpoint configuration
- url, secret (HMAC signing)
- events (JSON): lead.created, order.created, order.updated
- failure_count for backoff
- **WebhookDelivery**: Delivery tracking
- idempotency_key for deduplication
- Retry logic: attempt_count, max_attempts, next_retry_at
- signature (HMAC)
- duration_ms for performance

13.3 Background Tasks

Database-backed job queue:

- **Task**: Queue entries
- name, payload (JSON)
- status: pending, processing, completed, failed, dead_letter
- Retry logic: retry_count, max_retries, next_retry_at
- priority (-10 low to +10 high)
- Exponential backoff calculation
- **CronTask**: Scheduled jobs
- schedule: @hourly, @daily, @weekly, or cron expression
- last_run, next_run tracking
- **WorkerHeartbeat**: Worker health monitoring
- tasks_processed, tasks_failed counters

14 Security Architecture

Defense-in-depth across multiple layers.

14.1 Input Validation

- WTForms with field-specific validators
- Bleach HTML sanitization for rich text
- SQLAlchemy parameterized queries (no raw string interpolation)
- JSON schema validation for API payloads

14.2 Security Headers

```
Content-Security-Policy: default-src 'self'; ...
X-Content-Type-Options: nosniff
X-Frame-Options: SAMEORIGIN
X-XSS-Protection: 1; mode=block
Strict-Transport-Security: max-age=31536000; includeSubDomains
Referrer-Policy: strict-origin-when-cross-origin
Permissions-Policy: geolocation=(), microphone=(), camera=()
```

14.3 CSRF Protection

Flask-WTF CSRF tokens on all state-changing forms. API endpoints use bearer token authentication.

14.4 Rate Limiting

Configurable limits on:

- Login attempts (5/minute per IP)
- Password reset requests (3/hour per email)
- API endpoints (configurable per-route)
- Form submissions (prevent spam)

14.5 Attack Prevention

- **LoginAttempt**: Brute force detection
- **IPBlacklist**: Automatic and manual blocking
- Progressive delays on failed logins
- Device fingerprinting
- GeoIP anomaly detection

15 Compliance & Privacy

15.1 GDPR Compliance

- **DataExportRequest**: One-click personal data export
- Format: JSON or CSV
- Processing status tracking
- Download expiration
- Right to deletion workflow
- **ConsentRecord**: Consent audit trail
- consent_type: analytics, marketing, necessary, functional
- consent_source, policy_version tracking
- IP and user agent logging

15.2 Data Retention

- **RetentionPolicy**: Configurable policies
- data_type, table_name targeting
- retention_days
- action: delete, anonymize, archive
- execution_interval_hours
- **DataRetentionLog**: Execution audit
- Records processed/deleted/anonymized/archived counts

15.3 Audit Logging

- **AuditLog**: Complete audit trail
- action, target_type, target_id
- details (JSON) for changesets
- ip_address, timestamp
- User attribution

15.4 Accessibility (WCAG 2.1 AA)

- Skip navigation links
- Proper heading hierarchy (single H1 per page)
- ARIA labels and roles on interactive elements
- Focus management for modals and drawers
- Screen reader tested (NVDA, VoiceOver)
- Keyboard navigation for all functionality

16 Infrastructure & Operations

16.1 Backup System

- **Backup**: Backup records
- backup_type: database, media, full
- status: pending, in_progress, completed, failed
- Verification: verified, verification_date
- checksum (SHA-256) for integrity
- encrypted flag
- storage_location: local, s3, azure
- **BackupSchedule**: Automated backups
- frequency: hourly, daily, weekly, monthly
- retention_days
- Custom cron expressions

16.2 Feature Flags

Gradual rollout support:

- **FeatureFlag**: Feature toggles
- is_enabled, rollout_percentage (0-100)
- user_whitelist / user_blacklist
- segment_ids targeting
- Date scheduling: starts_at, ends_at
- Deterministic rollout by user ID

16.3 Deployment Tracking

- **DeploymentLog**: Deployment history
- version, environment
- status: in_progress, success, failed, rolled_back
- rollback_version for recovery
- commit_sha for traceability
- migration_ran flag

16.4 Observability

Production-ready monitoring:

- Structured JSON logging with correlation IDs
- Prometheus-compatible /metrics endpoint
- Health checks: application, database, Redis, disk space
- Request timing and slow query logging
- Sentry integration (optional)

- Worker heartbeat monitoring

17 React Component Library

44 TypeScript React components organized by domain:

17.1 Admin Components

- AdminDataTable: Sortable, filterable data tables
- AdminDashboard: KPI cards and metrics
- EmailTemplateCards: Template gallery with preview

17.2 Analytics

- AnalyticsDashboard: Traffic and conversion charts

17.3 Booking

- BookingWizard: Multi-step booking flow
- BookingPage: Full booking interface
- DateTimePicker: Date/time selection

17.4 Calendar

- FullCalendar integration
- Availability management

17.5 Cart & Shop

- ShoppingCartWidget: Cart drawer/widget
- ProductGallery: Image galleries
- ImageGallery: Lightbox galleries

17.6 Charts

- Chart: Recharts-based visualizations
- Line, bar, pie, area charts

17.7 CRM

- KanbanBoard: Drag-and-drop lead management
- Pipeline visualization

17.8 Forms

- FormBuilder: Dynamic form creation
- FormRenderer: Form display

17.9 Messaging

- MessageThread: Chat interface

17.10 Notifications

- NotificationBell: Real-time notifications
- Toast: Notification toasts

17.11 UI Components

- Button, Input, Select, Textarea
- Modal, Dropdown, Sheet
- Card, Badge, Spinner
- Tabs, Accordion

17.12 Layout

- Header, Footer, Navigation
- HomePage with glassmorphism design

18 API Reference

REST API with OpenAPI documentation at /api/docs.

18.1 Authentication

- API keys with scoped permissions
- Bearer token authentication
- Key hashing (SHA-256) for security
- Last-used tracking

18.2 Available Scopes

- read:leads, write:leads
- read:orders, write:orders
- read:products, write:products
- read:appointments, write:appointments
- read:users (admin only)

18.3 Core Endpoints

- /api/v1/leads - Lead management
- /api/v1/orders - Order operations
- /api/v1/products - Product catalog
- /api/v1/appointments - Booking API
- /api/v1/cart - Cart operations
- /api/v1/notifications - Notification management

19 Deployment Options

19.1 Sovereign Path: Raw VPS

Ubuntu/Debian + Gunicorn + Nginx. Fixed monthly cost. Air-gappable. Complete control.

```
gunicorn -w 4 -b 0.0.0.0:8000 "app:create_app()"
```

19.2 Hybrid Path: PaaS

Heroku, Dokku, Railway with Procfile. Quick deployment, managed SSL.

19.3 Container Path: Docker/Kubernetes

- Dockerfile included
- Kubernetes manifests in /k8s
- Helm charts in /helm

19.4 Edge Path: On-Premises

Raspberry Pi, Jetson, air-gapped servers. Identical codebase. Zero external dependencies for core functionality.

20 Economic Analysis

20.1 SaaS Stack Cost Comparison

For a 50-person company at 100k MAU:

Function	SaaS Stack	Verso
Auth (Auth0/Clerk)	$1,800/mo	$0
CMS (Contentful/Sanity)	$489/mo	$0
E-commerce (Shopify Plus)	$2,000/mo	$0
Scheduling (Calendly Enterprise)	$1,250/mo	$0
Analytics (Mixpanel/Amplitude)	$1,000/mo	$0
Email Marketing (Klaviyo)	$700/mo	$0
Messaging (Slack Business+)	$750/mo	$0
CRM (HubSpot)	$500/mo	$0
Forms (Typeform)	$200/mo	$0
Surveys (Delighted)	$224/mo	$0
Push (OneSignal)	$100/mo	$0
Hosting	$200/mo	$20-100
Total	**$9,213/mo**	**$20-100/mo**
Annual	**$110,556**	**$240-1,200**

Table 4: Total Cost of Ownership Comparison

21 Future Roadmap

21.1 Phase 34: Mobile Applications

React Native companion apps sharing the Verso API for iOS and Android.

21.2 Phase 35: Multi-Tenancy

Organizational boundaries for agencies managing multiple clients from one instance.

21.3 Phase 36: Marketplace

Plugin architecture for community-contributed modules.

21.4 Phase 37: AI Expansion

Deeper AI integration for content generation, customer service automation, and predictive analytics.

21.5 Phase 38: CalDAV/CardDAV

Standard calendar and contact sync for native mobile integration.

22 Conclusion

Verso is not just software—it is a declaration of independence. By consolidating business functions into a sovereign, simplified, and frugal operating system, we empower founders to build enduring institutions rather than renting their operations from Silicon Valley platforms.

The Verso stack proves that:

- A carefully architected monolith can deliver microservice-level modularity
- Server-side rendering with strategic React islands provides optimal UX
- "Lindy" technologies (Python, SQL, HTML) outperform framework churn
- Data sovereignty is achievable without sacrificing modern capabilities
- Enterprise features don't require enterprise pricing
- 120+ database models can coexist in a maintainable schema
- 45 route modules can serve as logical microservice boundaries

Claim your sovereignty. Ship the monolith. Sleep at night.