Sweep ESG Sustainability Reporting - PRD to Architecture Traceability Matrix

Overview

This traceability matrix demonstrates complete alignment between product requirements defined in the PRD and the proposed technical architecture components. Each requirement is mapped to specific architectural elements with detailed notes on implementation approach.

Traceability Matrix

Requirement ID	Requirement Description	Related Architecture Component(s)	Notes on Architecture Implementation
SECURITY & COMPLIANCE			
R1	Security Certifications & Compliance	Security & Compliance Layer (IAM, KMS, Audit Controls)	Implements SOC 2 Type II, ISO 27001 standards with comprehensive audit logging, encryption at rest/transit, and compliance monitoring
M1.3	Multi-tenant Architecture & Security Framework	Security & Compliance Layer + API Gateway	RBAC implementation with tenant isolation, encrypted data segregation, role-based access controls across all services
DATA COLLECTION & INGESTION			
REQ-DC-001	Automated Data Import from Multiple Sources	Microservices: ESG Data Management + Integration Layer	REST APIs supporting CSV, Excel, PDF uploads; automated data pipelines with validation and transformation
REQ-DC-002	Real-time Data Synchronization	Integration Layer + Event Bus (Kafka/SNS/SQS)	Event-driven architecture enabling real-time data streaming and synchronization across systems
REQ-DC-003	Data Format Standardization	ESG Data Management Service + Data Transformation Engine	Automated unit conversions, standardization rules, and data normalization processes
REQ-DC-004	Third-party System Integration	Integration Layer + API Gateway	Pre-built connectors for ERP systems, utility providers, and sustainability platforms

Requirement ID	Requirement Description	Related Architecture Component(s)	Notes on Architecture Implementation
REQ-DC-005	Manual Data Entry Interface	Frontend (React.js UI) + Data Validation Service	Intuitive forms with real-time validation, bulk upload capabilities, and guided data entry workflows
EMISSIONS MANAGEMENT			
REQ-EM-001	GHG Protocol Scope 1, 2, 3 Calculations	ESG Data Management Service + Calculation Engine	Automated calculation engines implementing latest GHG Protocol methodologies with regional emission factors
REQ-EM-002	Regional Emission Factor Support	Calculation Engine + Reference Data Service	Global emission factor database with automatic updates and regional customization capabilities
REQ-EM-003	Carbon Footprint Tracking	ESG Data Management + TimescaleDB	Time-series data storage optimized for carbon footprint trending and historical analysis
REQ-EM-004	Baseline Year Management	Data Management Service + PostgreSQL	Version control for baseline data with change tracking and audit trails
REQ-EM-005	Emissions Forecasting & Targets	Analytics Engine + ML Services	Predictive modeling for emissions forecasting and automated target tracking with variance analysis
DATA QUALITY & VALIDATION			
REQ-DQ-001	AI-Powered Data Anomaly Detection	AI Data Cleansing & Validation Service	Machine learning algorithms for statistical anomaly detection and pattern recognition
REQ-DQ-002	Duplicate Data Identification & Removal	AI Data Cleansing Service + PostgreSQL	Intelligent deduplication using fuzzy matching and similarity algorithms
REQ-DQ-003	Data Completeness Validation	Data Validation Service + Workflow Engine	Automated completeness checks with workflow triggers for missing data resolution
REQ-DQ-004	Data Accuracy Scoring	AI Data Cleansing Service + Analytics Engine	ML-based accuracy scoring with confidence intervals and quality metrics dashboards
REQ-DQ-005	Data Quality Dashboard	Frontend (React.js) + Analytics Service	Real-time data quality metrics visualization with drill-down capabilities and quality trends

Requirement ID	Requirement Description	Related Architecture Component(s)	Notes on Architecture Implementation
REPORTING & COMPLIANCE			
REQ-REP-001	Multi-Standard Report Generation	Compliance & Reporting Service + Template Engine	Automated report generation supporting GRI, SASB, TCFD, CDP, and custom frameworks
REQ-REP-002	Report Template Management	Reporting Service + MongoDB	Flexible template storage with versioning, customization, and collaborative editing capabilities
REQ-REP-003	Automated Report Scheduling	Workflow & Notifications Service + Job Scheduler	Cron-based scheduling with automated distribution and stakeholder notifications
REQ-REP-004	Report Version Control	Reporting Service + PostgreSQL	Complete audit trail for report versions with change tracking and rollback capabilities
REQ-REP-005	Export Capabilities (PDF, Excel, CSV)	Reporting Service + Document Generation Engine	Multi-format export with customizable layouts and automated formatting
REQ-REP-006	Regulatory Compliance Validation	Compliance Service + Rule Engine	Automated compliance checking against regulatory requirements with gap analysis
USER INTERFACE & EXPERIENCE			
M1.4	React.js Frontend with Dashboards	Frontend (React.js UI) + State Management	Modern SPA with responsive design, interactive dashboards, and intuitive data entry interfaces
REQ-UI-001	Interactive Data Visualization	Frontend + Charting Libraries + Analytics Service	Dynamic charts, graphs, and maps with real-time data updates and export capabilities
REQ-UI-002	Mobile-Responsive Design	Frontend (React.js) with Responsive Framework	Mobile-first design approach with touch-optimized interfaces and offline capabilities
REQ-UI-003	Role-Based Dashboard Customization	Frontend + User Management Service + PostgreSQL	Personalized dashboards with role-based content and drag-drop customization
SUPPLIER & VALUE CHAIN			

Requirement ID	Requirement Description	Related Architecture Component(s)	Notes on Architecture Implementation
REQ-SUP-001	Supplier Onboarding Portal	Supplier & Value Chain Service + Portal Interface	Self-service supplier registration with guided onboarding workflows and document management
REQ-SUP-002	Supplier Data Collection Automation	Integration Layer + Supplier Service	Automated data collection from supplier systems with validation and quality checks
REQ-SUP-003	Supplier Performance Dashboards	Analytics Service + Frontend	Real-time supplier sustainability performance tracking with benchmarking and scorecards
REQ-SUP-004	Value Chain Impact Assessment	Analytics Engine + Calculation Service	Comprehensive value chain analysis with hotspot identification and impact quantification
WORKFLOW & AUTOMATION			
REQ-WF-001	Automated Workflow Engine	Notifications & Workflow Service + Rule Engine	Business process automation with conditional logic, approvals, and escalation management
REQ-WF-002	Task Assignment & Tracking	Workflow Service + User Management + PostgreSQL	Automated task assignment with progress tracking, deadlines, and performance metrics
REQ-WF-003	Notification System	Notifications Service + Communication Gateway	Multi-channel notifications (email, SMS, in-app) with personalization and delivery tracking
REQ-WF-004	Approval Workflows	Workflow Engine + User Management Service	Configurable approval chains with delegation, escalation, and audit trail capabilities
REQ-WF-005	Escalation Management	Workflow Service + Business Rules Engine	Intelligent escalation based on SLAs, priority levels, and organizational hierarchy
ANALYTICS & INSIGHTS			
REQ-AN-001	Trend Analysis & Forecasting	Analytics Engine + TimescaleDB + ML Services	Advanced analytics with predictive modeling, trend identification, and scenario planning
REQ-AN-002	Benchmarking Capabilities	Analytics Service + External Data Integration	Industry benchmarking with peer comparison and best practice recommendations

Requirement ID	Requirement Description	Related Architecture Component(s)	Notes on Architecture Implementation
REQ-AN-003	Performance KPI Tracking	Analytics Engine + Dashboard Service	Automated KPI calculation and tracking with goal setting and variance analysis
REQ-AN-004	Custom Report Builder	Reporting Service + Query Engine	Drag-drop report builder with custom calculations, filters, and visualization options
TECHNICAL ARCHITECTURE			
TECH-ARCH-001	Microservices Architecture	All Microservices + API Gateway + Service Mesh	Loosely coupled services with independent scaling, deployment, and technology choices
TECH-ARCH-002	CI/CD Pipeline Automation	DevOps & Observability Layer	Automated testing, deployment, and monitoring with blue-green deployments and rollback capabilities
TECH-ARCH-003	API-First Design	API Gateway + All Microservices	RESTful and GraphQL APIs with comprehensive documentation, versioning, and rate limiting
TECH-ARCH-004	Cloud-Native Architecture	Container Orchestration + Cloud Services	Kubernetes deployment with auto-scaling, fault tolerance, and multi-region support
TECH-ARCH-005	Event-Driven Architecture	Event Bus (Kafka/SNS/SQS) + Event Processors	Asynchronous communication enabling real-time processing, scalability, and resilience
DATA STORAGE & MANAGEMENT			
DATA-001	Multi-Modal Data Storage	PostgreSQL + TimescaleDB + MongoDB	Optimized storage for relational data, time-series metrics, and document-based content
DATA-002	Data Backup & Recovery	Backup Service + Cloud Storage	Automated backup with point-in-time recovery, cross-region replication, and disaster recovery
DATA-003	Data Archival & Retention	Data Lifecycle Management + Archive Storage	Automated data archival based on retention policies with compliance and audit requirements
PERFORMANCE & SCALABILITY			

Requirement ID	Requirement Description	Related Architecture Component(s)	Notes on Architecture Implementation
PERF-001	High Availability Architecture	Load Balancers + Multi-AZ Deployment	99.9% uptime SLA with automatic failover, health checks, and circuit breakers
PERF-002	Auto-Scaling Capabilities	Container Orchestration + Metrics Monitoring	Horizontal and vertical scaling based on demand with cost optimization
PERF-003	Performance Monitoring	Observability Layer + APM Tools	Real-time performance monitoring with alerting, tracing, and performance optimization

Architecture Coverage Summary

Complete Coverage Verification

✅ **Security & Compliance**: All security requirements mapped to dedicated security layer with comprehensive controls

✅ **Data Management**: Full data lifecycle coverage from ingestion to archival with appropriate storage technologies

✅ **Business Logic**: All business requirements mapped to specific microservices with clear separation of concerns

✅ **User Experience**: Frontend requirements fully addressed with modern React.js architecture and responsive design

✅ **Integration**: API-first and event-driven architecture ensures seamless system integration

✅ **Operations**: Complete DevOps and monitoring coverage for production readiness

Key Architectural Decisions Supporting Requirements

- **Microservices Pattern**: Enables independent scaling and development of different business capabilities

- **Event-Driven Design**: Supports real-time data processing and workflow automation requirements

- **Multi-Modal Storage**: Optimized data storage for different data types and access patterns

- **API Gateway**: Centralized security, rate limiting, and API management

- **Container Orchestration**: Scalable, resilient deployment supporting high availability requirements

This traceability matrix ensures 100% coverage of PRD requirements in the technical architecture, providing a clear foundation for development planning, testing strategies, and compliance validation.