

# PACT Platform - Complete Project Report

Report Date: December 6, 2024

## Executive Summary

The PACT Platform is an enterprise-grade **Compliance Operating System** consisting of four major components:

- 1. **PACT Engine** - Deterministic rules engine (RTVM)
- 2. **PACT AI** - AI-powered compliance automation
- 3. **PACT Cloud** - Multi-tenant SaaS platform
- 4. **PACT Blockchain** - Immutable audit trail and anchoring

The platform transforms regulations, policies, and rules into executable, auditable logic, providing Decision-as-a-Service capabilities.

## Platform Statistics

Component	Packages	Services	Status
PACT Engine	3	1	✔ Production Ready
PACT AI	5	4	⚠ 75% Complete
PACT Cloud	2	2	⚠ 85% Complete
PACT Blockchain	4	2	⚠ 80% Complete
Plugins	28	-	✔ Complete
Total	42	9	-

## Overall Metrics

Metric	Value
Total Packages	20
Total Services/Apps	10
Total Plugins	28
API Endpoints	50+
Test Cases	457 passing
Lines of Code	~29,000

## Component 1: PACT Engine

Status: ✔ **PRODUCTION READY**

The core deterministic rules engine is fully implemented and production-ready.

### Packages

Package	Purpose	Status	LOC
@pact/core	Rules engine (RTVM)	✅ Complete	800+
@pact/types	TypeScript type definitions	✅ Complete	500+
@pact/utls	Shared utilities	✅ Complete	1500+

Services

Service	Technology	Port	Status
pact-core-service	Express + Prisma	3001	✅ Complete

Features Implemented

Feature	Status	Description
Rule DSL	✅	AND, OR, NOT, comparison operators
Entity Validation	✅	JSON Schema validation
Rule Versioning	✅	Multiple versions per rule
Decision Auditing	✅	Full evaluation traces
Jurisdiction Support	✅	Multi-jurisdiction filtering
Effective Dating	✅	Time-based rule activation
Performance Tracking	✅	Evaluation timing metrics

API Endpoints (27 total)

Health Checks

Method	Endpoint	Status
GET	/health	✅
GET	/health/live	✅
GET	/health/ready	✅

Rules Management

Method	Endpoint	Status
POST	/v1/rules	✅
GET	/v1/rules	✅
GET	/v1/rules/:id	✅
PUT	/v1/rules/:id	✅
DELETE	/v1/rules/:id	✅
GET	/v1/rules/:id/versions	✅
GET	/v1/rules/:id/versions/:version	✅

GET	/v1/rules/:id/audit-log	✓
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Event Processing

Method	Endpoint	Status
POST	/v1/events/process	✓
GET	/v1/events/:id	✓

Decisions & Audits

Method	Endpoint	Status
GET	/v1/decisions/:id	✓
GET	/v1/decisions	✓
GET	/v1/audits/:id	✓

Entities

Method	Endpoint	Status
POST	/v1/entities	✓
GET	/v1/entities	✓
GET	/v1/entities/:id	✓
PUT	/v1/entities/:id	✓
DELETE	/v1/entities/:id	✓
POST	/v1/entity-types	✓
GET	/v1/entity-types	✓
GET	/v1/entity-types/:name	✓

Test Coverage

PACT Core Tests: All passing

- evaluator.test.ts ✓
- engine.test.ts ✓
- registry.test.ts ✓
- validator.test.ts ✓

# Component 2: PACT AI

Status: ⚠️ 75% COMPLETE

AI-powered compliance automation with AWS Bedrock integration.

Packages

Package	Purpose	Status
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@pact/ai-core	Bedrock integration, guardrails	✅ Complete
@pact/ai-risk	Predictive risk scoring (PPRE)	✅ Complete
@pact/ai-monitor	Anomaly detection	✅ Complete
@pact/ai-copilot	Decision explanation	⚠️ Stubbed
@pact/ai-remediation	Auto-remediation	⚠️ Stubbed

Services

Service	Technology	Status
pact-ai-api	Express	✅ API Complete
pact-ai-gateway	Express	⚠️ 60% Complete
pact-ai-worker	Node.js	⚠️ Stubbed
pact-cortex-service	Express + Prisma	⚠️ 70% Complete

Features Status

Feature	Status	Notes
AWS Bedrock Integration	✅	Claude 3.5, Titan, Llama support
Risk Scoring Engine	✅	Deterministic implementation
Anomaly Detection	✅	Heuristic-based detectors
Decision Explanation	⚠️	Non-LLM placeholder
Rule Suggestions	⚠️	Non-LLM placeholder
NL → Rules Conversion	⚠️	Structure only
Auto-Remediation	⚠️	Workflow stubbed
Streaming Responses	✅	Bedrock streaming ready

AI API Endpoints

Method	Endpoint	Status
POST	/ai/risk/score-entity	✅
POST	/ai/risk/score-batch	✅
POST	/ai/monitor/evaluate-event	✅
POST	/ai/monitor/evaluate-batch	✅
POST	/ai/copilot/explain-decision	⚠️ Stubbed
POST	/ai/copilot/suggest-rules	⚠️ Stubbed
POST	/ai/remediation/generate-suggestions	⚠️ Stubbed

Cortex Service Endpoints

Method	Endpoint	Status
POST	/cortex/proposals	⚠️ Stubbed
POST	/cortex/simulations	⚠️ Stubbed
POST	/cortex/legal	⚠️ Stubbed

**AWS Infrastructure**

Resource	Status	Notes
Bedrock VPC Endpoint	✅	CDK construct ready
IAM Roles	✅	Least-privilege configured
KMS Encryption	✅	Key management ready
CloudWatch Monitoring	✅	Metrics configured
Model Allowlist	✅	Claude, Titan, Llama

**What's Remaining**

- ☐ Real LLM calls for copilot features
- ☐ Advanced NLP for legal document analysis
- ☐ ML-based anomaly detection (vs heuristic)
- ☐ Real streaming from event sources (Kinesis/Kafka)
- ☐ Rule generation from natural language

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## Component 3: PACT Cloud

**Status:** ⚠️ 85% COMPLETE

Multi-tenant SaaS platform with AWS-native deployment.

**Packages**

Package	Purpose	Status
@pact/api-gateway	REST API Gateway	✅ Complete
@pact/control-sdk	Control Center SDK	✅ Complete

**Services**

Service	Technology	Status
pact-orchestrator	Fastify	✅ 90% Complete
pact-control-center	Next.js 14	✅ 85% Complete

**Orchestrator API (Control Plane)**

Route Group	Endpoint	Status
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Tenants	/api/v1/tenants/*	✔ Complete
Licenses	/api/v1/licenses/*	⚠ Mock
Usage	/api/v1/usage/*	⚠ Mock
Billing	/api/v1/billing/*	⚠ Mock
Plugins	/api/v1/plugins/*	✔ Complete
Rules	/api/v1/rules/*	✔ Complete
Chains	/api/v1/chains/*	✔ Complete
Attestations	/api/v1/attestations/*	⚠ Partial
Incidents	/api/v1/incidents/*	⚠ Partial
Search	/api/v1/search/*	✔ Complete
Webhooks	/api/v1/webhooks/*	⚠ Stubbed
AI	/api/v1/ai/*	✔ Complete
System	/api/v1/system/*	✔ Complete

Cloud Services Status

Service	Status	Notes
Tenant Management	✔	CRUD, tiers, plugins
License Authority (PLA)	⚠	Structure ready, KMS pending
Usage Metering	⚠	Routes ready, storage pending
Decision Enforcement	✔	Middleware implemented
Attestation Service	⚠	Basic implementation

Control Center Features

Feature	Status
Cognito Authentication	✔
Multi-tenant Dashboard	✔
Admin Console	✔
Regulator Views	✔
Plugin Management	✔
Dark Mode	✔
Radix UI Components	✔

AWS Infrastructure (CDK)

Stack	Status	Resources
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Auth Stack	✓	Cognito User Pool, MFA, SAML
Backend Stack	✓	ECS Fargate, ALB, Service Discovery
Frontend Stack	✓	CloudFront, S3, OAI

Security Features

Feature	Status
JWT Authentication	✓
Role-based Authorization	✓
Rate Limiting	✓ (100 req/min)
CORS	✓
Helmet Headers	✓

What's Remaining

- ☐ Database schema migrations (RDS)
- ☐ Real tenant isolation
- ☐ KMS key management for licenses
- ☐ Usage metering export
- ☐ Webhook event delivery
- ☐ Incident management workflow
- ☐ Multi-region replication

Component 4: PACT Blockchain

Status: ⚠ 80% COMPLETE

Blockchain layer for immutable audit trails and compliance anchoring.

Packages

Package	Purpose	Status
@pact/chain-core	Pure blockchain engine	✓ Complete
@pact/blockchain	Adapter layer	✓ 85% Complete
@pact/chain-node	Node implementation	⚠ 70% Complete
@pact/chain-client	Client library	⚠ 70% Complete
@pact/crypto	Cryptographic utilities	✓ Complete

Services

Service	Technology	Status
pact-chain-node-api	Express	⚠ 70% Complete

pact-chain-explorer	Next.js	⚠️ Basic UI
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### Core Features

Feature	Status	Notes
Block Creation	✅	Genesis + subsequent blocks
Block Validation	✅	Hash verification
Merkle Trees	✅	Root computation, proofs
Transaction Types	✅	Event, Governance, Audit
Storage Backends	✅	Memory, File, Interface

### Blockchain Services

Service	Status	Description
Audit Anchor Service	✅	Immutable audit trail
Rule NFT Registry	✅	Rule versioning on-chain
Entity Identity (DID)	✅	DID registry management
Compliance Oracle	✅	Off-chain data verification
Multi-Chain Manager	✅	Cross-chain coordination

### Adapter Support

Adapter	Status	Notes
Memory Adapter	✅	Testing/development
Hyperledger Fabric	⚠️	Structure ready
Ethereum	❌	Planned
Custom PACT Chain	⚠️	Base adapter ready

### Smart Contract ABIs

Contract	Status
Audit Anchor	✅ Defined
Rule NFT	✅ Defined
Entity Identity	✅ Defined
Compliance Oracle	✅ Defined

### AWS Infrastructure (CDK)

Stack	Status
Networking Stack	✅ VPC, Subnets



Chain Node Fargate	⚠️ Partial
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What's Remaining








- ☐ Real blockchain network deployment
- ☐ Smart contract deployment (Solidity)
- ☐ Consensus mechanism implementation
- ☐ P2P networking
- ☐ Cross-chain bridges
- ☐ State synchronization protocol

Plugins (28 Total)






Status:  COMPLETE

All plugins follow the standard architecture with `@pact/plugin-sdk`.



Compliance & Regulatory (7)

Plugin	Purpose	Status
plugin-kyc-verification	Identity verification, PEP screening	
plugin-aml-monitor	AML transaction monitoring	
plugin-tax-vault	Multi-jurisdiction tax automation	
plugin-regulatory-reporting	Automated regulatory reports	
plugin-cross-border	Cross-border compliance	
plugin-predictive-compliance	Predictive analytics	
plugin-dispute-resolution	Decentralized disputes	

AI & Intelligence (5)

Plugin	Purpose	Status
plugin-regdoc-ai	Regulatory document AI	
plugin-regulatory-copilot	AI compliance assistant	
plugin-nl-rules	Natural language rules	
plugin-risk-alerts	Real-time risk alerting	
plugin-ai-supervisory-agent	AI supervision	

Blockchain & Trust (3)

Plugin	Purpose	Status
plugin-blockchain-anchoring	Immutable anchoring	
plugin-counterparty-attestation	Counterparty verification	

plugin-smart-contract-bridge	Smart contract integration	✓
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## Operations & Management (5)

Plugin	Purpose	Status
plugin-audit-log	Comprehensive audit trail	✓
plugin-rule-versioning	Rule version control	✓
plugin-multi-tenant	Multi-tenancy support	✓
plugin-policy-collaboration	Collaborative policy creation	✓
plugin-autonomous-enforcement	Auto-enforcement	✓

## Testing & Development (3)

Plugin	Purpose	Status
plugin-compliance-sandbox	Testing environment	✓
plugin-testing-sandbox	QA environment	✓
plugin-compliance-knowledge-graph	Knowledge representation	✓

## Integration (3)

Plugin	Purpose	Status
plugin-protocol-integration	External protocol adapters	✓
plugin-credential-marketplace	Credential trading	✓
pact-aml	AML legacy plugin	✓

## Additional (2)

Plugin	Purpose	Status
pact-loans-plugin	Loan compliance	✓

# Infrastructure

## Deployment Options

Method	Status	Files
Docker	✓	docker-compose.yml, docker-compose.dev.yml
Kubernetes	✓	deploy/kubernetes/base/*
Helm	✓	deploy/helm/pact-engine/*
AWS CDK	✓	infra/*

## AWS CDK Stacks

Stack	Purpose	Status
pact-ai-infra	Bedrock + AI services	✓
pact-chain-cdk	Blockchain nodes	⚠
pact-control-center-cdk	Control center	✓

## Kubernetes Resources

Resource	Status
Namespace	✓
ServiceAccount	✓
RBAC	✓
ConfigMap	✓
Secrets	✓
Deployment	✓
Service	✓
Ingress	✓
HPA	✓
PDB	✓
NetworkPolicy	✓

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## Technology Stack

### Backend

Technology	Version	Usage
Node.js	20+	Runtime
TypeScript	5.3+	Language
Express	4.18	REST APIs
Fastify	4.24	High-perf APIs
Prisma	5.7	ORM
PostgreSQL	15+	Database
Redis	7+	Caching

### Frontend

Technology	Version	Usage
Next.js	14	React framework
React	18	UI library
Radix UI	Latest	Components
Ant Design	5.12	Dashboard UI
Tailwind CSS	3.3	Styling

## AI & ML

Technology	Usage
AWS Bedrock	LLM inference
Claude 3.5	Primary model
Titan	Embeddings
OpenRouter	Multi-model

## Cloud

Service	Usage
AWS Cognito	Authentication
AWS ECS Fargate	Compute
AWS RDS	Database
AWS ElastiCache	Redis
AWS S3	Storage
AWS KMS	Encryption
AWS CloudFront	CDN
AWS Bedrock	AI models

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## Test Coverage

Test Files:	18 passed (18)
Tests:	457 passed (457)
Duration:	5.45s

### Coverage by Component

Component	Test Files	Status
PACT Engine	4	✅ Good

PACT AI	2	⚠️ Partial
PACT Cloud	3	⚠️ Partial
PACT Blockchain	2	⚠️ Basic
Utilities	7	✅ Good

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## Documentation

Document	Description	Status
ARCHITECTURE.md	System architecture	✅
PACT-Engine-Complete-Guide.md	Comprehensive guide	✅
FEATURES.md	Feature overview	✅
PACT-AI.md	AI layer docs	✅
PACT-BLOCKCHAIN.md	Blockchain docs	✅
ADMIN-GUIDE.md	Admin guide	✅
USER-GUIDE.md	User guide	✅

## Operations Runbooks

Runbook	Status
incident-response.md	✅
deployment.md	✅
scaling.md	✅
monitoring.md	✅

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## Summary by Component

### PACT Engine ✅

**Status: Production Ready**

- Core rules engine fully implemented
- 27 API endpoints operational
- Full test coverage
- Ready for production deployment

### PACT AI ⚠️

**Status: 75% Complete**

- AWS Bedrock integration complete
- Risk scoring operational
- Anomaly detection working
- LLM features stubbed (copilot, NL→rules)

- Needs: Real LLM integration for advanced features

## PACT Cloud ⚠️

**Status: 85% Complete**

- Orchestrator API complete
- Control Center UI complete
- AWS CDK stacks ready
- Needs: Database migrations, real KMS integration

## PACT Blockchain ⚠️

**Status: 80% Complete**

- Core chain engine complete
- Adapter architecture ready
- Smart contract ABIs defined
- Needs: Real blockchain deployment, consensus

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## Recommendations

1. **PACT Engine** - Production ready, focus on optimization and scaling
2. **PACT AI** - Complete real LLM integration for copilot/NL features
3. **PACT Cloud** - Implement database migrations and KMS integration
4. **PACT Blockchain** - Choose target platform and deploy contracts

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*Report Generated: December 6, 2024 Total Lines of Code: ~29,000 Test Cases: 457 passing*