VeritasChain Protocol (VCP) Specification

Version 1.0

Status: Production Ready
Category: Financial Technology / Audit Standards
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Maintainer: VeritasChain Standards Organization (VSO)

Website: https://veritaschain.org

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1. Introduction

1.1 Purpose

The VeritasChain Protocol (VCP) is a global standard specification for recording the "decision-making" and "execution results" of algorithmic trading in an immutable and verifiable format. VCP provides a cryptographically secured chain of evidence that

establishes truth ("Veritas") in trading operations, ensuring compliance with international regulations including MiFID II, GDPR, EU AI Act, and emerging quantum-resistant security requirements.

1.2 Scope

VCP applies to:

- High-Frequency Trading (HFT) systems
- Algorithmic and AI-driven trading platforms
- Retail trading systems (MT4/MT5)
- Cryptocurrency exchanges
- Regulatory reporting systems

1.3 Versioning

VCP adopts Semantic Versioning 2.0.0:

- MAJOR version: Incompatible API changes
- MINOR version: Backwards-compatible functionality additions
- PATCH version: Backwards-compatible bug fixes

Full backward compatibility is guaranteed within the v1.x series.

1.4 Crypto Agility

VCP implements crypto agility to ensure future-proof security:

- Current Default: Ed25519 (performance and security optimized)
- Supported Algorithms: Ed25519, ECDSA_SECP256K1, RSA_2048
- Future Reserved: Post-quantum algorithms (DILITHIUM, FALCON)
- Migration Path: Automated algorithm upgrade capability

1.5 Standard Enumerations

1.5.1 SignAlgo Enum

Value	Algorithm	Description	Status

ED25519	Ed25519	Edwards-curve Digital Signature	DEFAULT
ECDSA_SECP256K1	ECDSA secp256k1	Bitcoin/Ethereum compatible	SUPPORTED
RSA_2048	RSA 2048-bit	Legacy systems	DEPRECATED
DILITHIUM2	CRYSTALS-Dilithium	Post-quantum (NIST Level 2)	FUTURE
FALCON512	FALCON-512	Post-quantum (NIST Level 1)	FUTURE

1.5.2 HashAlgo Enum

Value	Algorithm	Description	Status
SHA256	SHA-256	SHA-2 family, 256-bit	DEFAULT
SHA3_256	SHA3-256	SHA-3 family, 256-bit	SUPPORTED
BLAKE3	BLAKE3	High-performance hash	SUPPORTED
SHA3_512	SHA3-512	SHA-3 family, 512-bit	FUTURE

1.5.3 ClockSyncStatus Enum

Value	Description	Tier Applicability

PTP_LOCKED	PTP synchronized with lock	Platinum
NTP_SYNCED	NTP synchronized	Gold
BEST_EFFORT	Best-effort synchronization	Silver
UNRELIABLE	No reliable synchronization	Silver (degraded)

1.5.4 TimestampPrecision Enum

Value	Description	Decimal Places
NANOSECOND	Nanosecond precision	9
MICROSECOND	Microsecond precision	6
MILLISECOND	Millisecond precision	3

1.6 Core Modules

- VCP-CORE: Standard header and security layer
- VCP-TRADE: Trading data payload schema
- VCP-GOV: Algorithm governance and AI transparency
- VCP-RISK: Risk management parameter recording
- VCP-PRIVACY: Privacy protection with crypto-shredding
- VCP-RECOVERY: Chain disruption recovery mechanism

1.7 Standardization Roadmap

Phase 1 (2025 Q1-Q2): Industry Standardization

- Release v1.0 specification
- Partner with FIX Trading Community
- Establish early adopter program

Phase 2 (2025 Q3-Q4): International Standardization

- Submit to ISO/TC 68 (Financial Services)
- Align with IETF standards
- Quantum-resistant upgrade path

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2. Compliance Tiers

2.1 Tier Definitions

Tier	Target	Clock Sync	Serialization	Signature	Anchor	Precision
Platinum	HFT/Exchange	PTP v2 (<1µs)	SBE	Ed25519 (Hardware)	10 min	NANOSECOND
Gold	Prop/Institutional	NTP (<1 ms)	JSON	Ed25519 (Client)	1 hour	MICROSECOND
Silver	Retail/MT4/5	Best-effort	JSON	Ed25519 (Delegated)	24 hours	MILLISECOND

2.2 Tier-Specific Requirements

2.2.1 Platinum Tier

```
Requirements:
  Clock:
    Protocol: PTPv2 (IEEE 1588-2019)
    Accuracy: <1 microsecond
    Status: PTP_LOCKED required
  Performance:
    Throughput: >1M events/second
    Latency: <10µs per event
    Storage: Binary (SBE/FlatBuffers)
  Implementation:
    Languages: [C++, Rust, FPGA]
    Techniques: [Kernel bypass, RDMA, Zero-copy]
```

2.2.2 Gold Tier

```
Requirements:
  Clock:
    Protocol: NTP/Chrony
    Accuracy: <1 millisecond
    Status: NTP_SYNCED required
  Performance:
    Throughput: >100K events/second
    Latency: <100µs per event
    Persistence: WAL/Queue required (Kafka, Redis)
  Implementation:
    Languages: [Python, Java, C#]
    Deployment: Cloud-ready (AWS/GCP/Azure)
```

2.2.3 Silver Tier

```
Requirements:
  Clock:
    Protocol: System time
    Accuracy: Best-effort
    Status: BEST_EFFORT/UNRELIABLE accepted
  Performance:
    Throughput: >1K events/second
    Latency: <1 second
    Communication: Async recommended
  Implementation:
    Languages: [MQL5, Python]
    Compatibility: MT4/MT5 DLL integration
```

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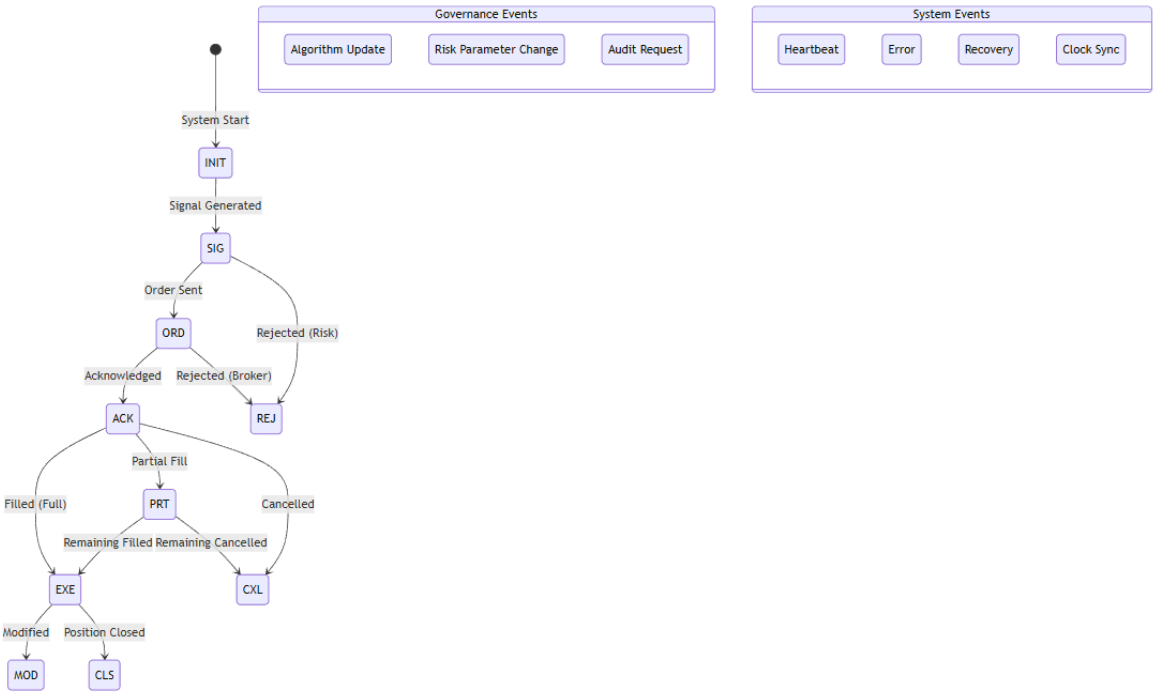
3. Event Lifecycle

3.1 Event State Diagram



3.2 Event Type Registry

3.2.1 Fixed Event Type Codes

CRITICAL: These codes are immutable for backward compatibility. New codes may only be added, never modified.

```
Trading Events (1-19):
1  = SIG    // Signal/Decision generated
2  = ORD    // Order sent
3  = ACK    // Order acknowledged
4  = EXE    // Full execution
5  = PRT    // Partial fill
6  = REJ    // Order rejected
7  = CXL    // Order cancelled
8  = MOD    // Order modified
9  = CLS    // Position closed
10-19       // Reserved for future trading events

Governance Events (20-39):
20 = ALG    // Algorithm update
21 = RSK    // Risk parameter change
22 = AUD    // Audit request
23-39       // Reserved for future governance events

Market Data Events (40-59):
40-59       // Reserved for future market data events

Compliance Events (60-79):
```

```
60-79       // Reserved for future compliance events

Infrastructure Events (80-89):
80-89       // Reserved for future infrastructure events

System Events (90-109):
98 = HBT    // Heartbeat
99 = ERR    // Error
100 = REC   // Recovery
101 = SNC   // Clock sync status
102-109     // Reserved for future system events

Extension Events (110-255):
110-255     // Reserved for custom implementations
```

3.2.2 Event Type Table

EventType	Code	Category	Description	Required Extensions
SIG	1	Trading	Signal/Decision generated	VCP-GOV
ORD	2	Trading	Order sent	VCP-TRADE, VCP-RISK
ACK	3	Trading	Order acknowledged	VCP-TRADE
EXE	4	Trading	Full execution	VCP-TRADE
PRT	5	Trading	Partial fill	VCP-TRADE
REJ	6	Trading	Order rejected	VCP-TRADE, VCP-RISK
CXL	7	Trading	Order cancelled	VCP-TRADE
MOD	8	Trading	Order modified	VCP-TRADE, VCP-GOV

CLS	9	Trading	Position closed	VCP-TRADE
ALG	20	Governance	Algorithm update	VCP-GOV
RSK	21	Governance	Risk parameter change	VCP-RISK
AUD	22	Governance	Audit request	VCP-GOV
HBT	98	System	Heartbeat	VCP-CORE
ERR	99	System	Error	VCP-CORE
REC	100	System	Recovery	VCP-RECOVERY
SNC	101	System	Clock sync status	VCP-CORE

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4. Data Model

4.1 VCP-CORE: Standard Header

4.1.1 Required Header Fields

Tag	Field	Type	Description	Requirements
1001	EventID	UUID	Unique event identifier	MUST use UUID v7 (time-sortable) or v4

1002	TraceID	UUID	Transaction trace ID (CAT Rule 613)	UUID v7 recommended
1010	Timestamp	Int64	Nanoseconds since Unix epoch (UTC)	MUST be monotonic within session
1011	EventType	Int8	Event type code	See Event Type Codes (Section 3.2.1)
1012	TimestampPrecision	Enum	Timestamp precision level	See TimestampPrecision Enum (Section 1.5.4)
1013	ClockSyncStatus	Enum	Clock synchronization status	See ClockSyncStatus Enum (Section 1.5.3)
1014	HashAlgo	Enum	Hash algorithm identifier	See HashAlgo Enum (Section 1.5.2)
1020	VenueID	String	Broker/Exchange identifier	ISO 10383 MIC code when applicable
1030	Symbol	String	Trading symbol	Normalized format required
1040	AccountID	String	Account identifier	MUST be pseudonymized

1050	OperatorID	String	Operator identifier (optional)	For manual intervention tracking

4.1.2 JSON Schema Example

```
{
  "EventID": "01934e3a-7b2c-7f93-8f2a-1234567890ab",
  "TraceID": "01934e3a-6a1b-7c82-9d1b-0987654321dc",
  "Timestamp": 1732358400000000000,
  "EventType": 2,
  "TimestampPrecision": "NANOSECOND",
  "ClockSyncStatus": "PTP_LOCKED",
  "HashAlgo": "SHA256",
  "VenueID": "XNAS",
  "Symbol": "AAPL",
  "AccountID": "acc_h7g8i9j0k1",
  "OperatorID": null
}
```

4.2 VCP-TRADE: Trading Payload

4.2.1 Standard Trading Fields

Tag	Field	Type	Description	Format Requirements
2001	OrderID	String	Client order ID	Unique per session
2002	BrokerOrderID	String	Broker order ID	From broker response
2003	ExchangeOrderID	String	Exchange order ID	From exchange
2010	Side	Enum	BUY/SELL	Uppercase only

2011	OrderType	Enum	MARKET/LIMIT/STOP/STOP_LIMIT	Standard FIX values
2020	Price	String	Order price	MUST be string for precision
2021	Quantity	String	Order quantity	MUST be string for precision
2022	ExecutedQty	String	Executed quantity	MUST be string for precision
2023	RemainingQty	String	Remaining quantity	MUST be string for precision
2030	Currency	String	Trading currency	ISO 4217 code
2031	ExecutionPrice	String	Actual fill price	MUST be string for precision
2040	Commission	String	Commission amount	MUST be string for precision
2041	Slippage	String	Slippage amount	MUST be string for precision
2050	RejectReason	String	Rejection reason	Standardized codes

4.2.2 Critical Precision Requirement

IEEE 754 Precision Issue: To maintain data integrity with RFC 8785 (JCS), all financial numeric values MUST be encoded as strings in JSON serialization:

```
{
  "Price": "123.456789",          // âœ“ Correct: String
  "Quantity": "1000.00",          // âœ“ Correct: String
  "ExecutedQty": "750.50",        // âœ“ Correct: String
  "Commission": "2.345678901"     // âœ“ Correct: String preserves precision
}
```

Never use:

```
{
  "Price": 123.456789,            // âœ— Wrong: Float loses precision
  "Quantity": 1000                // âœ— Wrong: Number type
}
```

---

5. Extension Modules

5.1 VCP-GOV: Algorithm Governance and AI Transparency

Integrates AI explainability (XAI), rule-based logic, and governance requirements (EU AI Act).

5.1.1 Schema Definition

```
{
  "VCP-GOV": {
    "Version": "1.0",
    "AlgorithmIdentification": {
      "AlgoID": "uuid",
      "AlgoVersion": "string",
      "AlgoType": "enum",              // AI_MODEL, RULE_BASED, HYBRID
      "ModelType": "string",           // NeuralNetwork, RandomForest, etc.
      "ModelHash": "string"            // SHA-256 of model parameters
    },
    "Governance": {
      "RiskClassification": "enum",    // HIGH/MEDIUM/LOW (EU AI Act)
      "LastApprovalBy": "OperatorID",  // Human oversight
      "ApprovalTimestamp": "int64",
      "TestingRecordLink": "uri",      // Backtesting results
      "AuditTrailID": "uuid"           // Link to audit records
    },
    "DecisionFactors": {
```

```
      "Features": [
        {
          "Name": "string",
          "Value": "string",              // Always string for precision
          "Weight": "string",
          "Contribution": "string"        // SHAP/LIME value
        }
      ],
      "ConfidenceScore": "string",        // 0.0-1.0 as string
      "ExplainabilityMethod": "enum",     // SHAP/LIME/GRADCAM/RULE_TRACE
      "RuleTrace": ["rule_id_1", "rule_id_2"]  // For rule-based
    },
    "PerformanceMetadata": {
      "CalculationMethod": "enum",        // SYNC, ASYNC, SAMPLED
      "SamplingRate": "string",           // 1.0=100%, 0.1=10%
      "LatencyImpact": "string"           // Microseconds added
    }
  }
}
```

5.2 VCP-RISK: Risk Management Snapshot

Records active risk management parameters at event time.

5.2.1 Schema Definition

```
{
  "VCP-RISK": {
    "Version": "1.0",
    "RiskProfile": {
      "ProfileID": "string",
      "ProfileVersion": "string",
      "LastModified": "int64"
    },
    "AppliedControls": [
      "ThrottleLimit",
      "MaxOrderSize",
      "FatFingerCheck",
      "PositionLimit",
      "VaRLimit"
    ],
    "ParametersSnapshot": {
      "MaxOrderSize": "1000000",
      "MaxPositionSize": "5000000",
      "DailyExposureLimit": "50000000",
      "ExposureUtilization": "0.75",
      "VaRLimit": "100000",
      "CurrentVaR": "67890.50",
      "ThrottleRate": "100",              // Orders per second
      "CircuitBreakerStatus": "NORMAL"
    },
```

```
    "TriggeredControls": [
      {
        "ControlName": "MaxOrderSize",
        "TriggerValue": "1500000",
        "Action": "REJECT",
        "Timestamp": "int64"
      }
    ]
  }
}
```

5.3 VCP-PRIVACY: Privacy Protection with Crypto-Shredding

Implements GDPR-compliant privacy with crypto-shredding capability.

5.3.1 Schema Definition

```
{
  "VCP-PRIVACY": {
    "Version": "1.0",
    "DataClassification": "enum",        // PUBLIC/INTERNAL/CONFIDENTIAL/RESTRICTED
    "PrivacyMethod": "enum",             // CLEAR/PSEUDONYMIZED/ENCRYPTED/REDACTED
    "Pseudonymization": {
      "Method": "AES-256-GCM",
      "KeyID": "uuid",                   // Reference to key management
      "Purpose": "string",               // Regulatory/Analytics/Audit
      "RetentionPeriod": "P7Y"           // ISO 8601 duration
    },
    "ConsentReference": "uuid",          // GDPR consent tracking
    "DataSubjectRights": {
      "Erasure": "CRYPTO_SHREDDING",     // Method for deletion
      "Portability": "JSON_EXPORT",
      "AccessLogID": "uuid"
    }
  }
}
```

5.4 VCP-RECOVERY: Chain Disruption Recovery

Handles chain breaks and recovery scenarios.

5.4.1 Schema Definition

```
{
  "VCP-RECOVERY": {
```

```
    "Version": "1.0",
    "RecoveryType": "enum",              // CHAIN_BREAK/FORK/REORG/CHECKPOINT
    "BreakPoint": {
      "LastValidEventID": "uuid",
      "LastValidHash": "string",
      "BreakTimestamp": "int64",
      "BreakReason": "string"
    },
    "RecoveryAction": {
      "Method": "enum",                  // REBUILD/SKIP/MERGE/CHECKPOINT
      "RecoveredEvents": 42,
      "ValidationMethod": "string",
      "OperatorID": "string"             // Who authorized recovery
    },
    "ChainValidation": {
      "PreBreakHash": "string",
      "PostRecoveryHash": "string",
      "MerkleProof": ["hash1", "hash2"],
      "AnchorReference": "string"        // External anchor point
    }
  }
}
```

---

6. Integrity and Security Layer (VCP-SEC)

6.1 Hash Chain Implementation

6.1.1 Event Hash Calculation

```python
def calculate_event_hash(header: dict, payload: dict, prev_hash: str, algo:
str = "SHA256") -> str:
    """
    Calculate event hash with RFC 8785 canonicalization
    """
    # Step 1: Canonicalize JSON (RFC 8785 JCS)
    canonical_header = canonicalize_json(header)
    canonical_payload = canonicalize_json(payload)

    # Step 2: Concatenate components
    hash_input = canonical_header + canonical_payload + prev_hash

    # Step 3: Apply hash function
    if algo == "SHA256":
        return hashlib.sha256(hash_input.encode()).hexdigest()
    elif algo == "SHA3_256":
        return hashlib.sha3_256(hash_input.encode()).hexdigest()
    elif algo == "BLAKE3":
```

```
        return blake3(hash_input.encode()).hexdigest()
    else:
        raise ValueError(f"Unsupported hash algorithm: {algo}")
```

6.1.2 Chain Validation

```
def validate_chain(events: List[dict]) -> bool:
    """
    Validate hash chain integrity
    """
    prev_hash = GENESIS_HASH  # "0000000000000000..."

    for event in events:
        # Recalculate hash
        calculated_hash = calculate_event_hash(
            event["Header"],
            event["Payload"],
            prev_hash,
            event["Header"]["HashAlgo"]
        )

        # Verify against stored hash
        if calculated_hash != event["Security"]["EventHash"]:
            return False

        prev_hash = calculated_hash

    return True
```

6.2 Digital Signatures

6.2.1 Signature Requirements

SignAlgo Enum	Use Case	Key Size	Performance	Quantum-Resistant
ED25519	Default	256-bit	Fastest	No
ECDSA_SECP256K1	Bitcoin compatibility	256-bit	Fast	No
RSA_2048	Legacy systems	2048-bit	Slow	No

DILITHIUM2	Future (reserved)	2420 bytes	Medium	Yes
FALCON512	Future (reserved)	897 bytes	Fast	Yes

6.2.2 Signature Generation

```
def sign_event(event_hash: str, private_key: bytes, algo: str = "ED25519") ->
str:
    """
    Generate digital signature
    """
    if algo == "ED25519":
        signing_key = Ed25519SigningKey(private_key)
        signature = signing_key.sign(event_hash.encode())
        return base64.b64encode(signature).decode()
    elif algo == "ECDSA_SECP256K1":
        # ECDSA implementation
        pass
    elif algo == "RSA_2048":
        # RSA implementation (legacy)
        pass
    else:
        raise ValueError(f"Unsupported signature algorithm: {algo}")
```

6.3 Merkle Tree Anchoring

6.3.1 RFC 6962 Compliance (Certificate Transparency)

MANDATORY: Merkle tree construction MUST follow RFC 6962 to prevent second preimage attacks:

```
def merkle_hash(data: bytes, leaf: bool = True) -> bytes:
    """
    RFC 6962 compliant Merkle tree hashing
    """
    if leaf:
        # Leaf nodes: 0x00 prefix
        return hashlib.sha256(b'\x00' + data).digest()
    else:
        # Internal nodes: 0x01 prefix
        return hashlib.sha256(b'\x01' + data).digest()
```

6.3.2 Anchoring Schedule

Tier	Frequency	Anchor Target	Proof Type
Platinum	10 minutes	Blockchain/TSA	Full Merkle proof
Gold	1 hour	TSA/Database	Merkle root + path
Silver	24 hours	Database/File	Merkle root only

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7. Implementation Guidelines

7.1 Language-Specific Recommendations

7.1.1 C++ (Platinum Tier)

```
// Recommended libraries
#include <sbe/sbe.hpp>           // Simple Binary Encoding
#include <sodium.h>              // libsodium for Ed25519
#include <folly/futures.hpp>     // Async processing
#include <spdk/nvme.h>          // NVMe direct access

// Performance optimizations
- Use lock-free data structures (boost::lockfree)
- Implement zero-copy serialization
- Enable compiler optimizations (-O3, -march=native)
- Use memory pools for allocation
```

7.1.2 Python (Gold Tier)

```
# Recommended packages
import asyncio                  # Async I/O
import orjson                   # Fast JSON
import msgpack                  # Binary serialization
from cryptography.hazmat.primitives import serialization
from cryptography.hazmat.primitives.asymmetric import ed25519
import redis                    # Persistence queue
import aiokafka                # Async Kafka client

# Performance optimizations
- Use uvloop for asyncio
- Implement connection pooling
```

```
- Use Redis streams or Kafka for WAL
- Profile with cProfile/py-spy
```

7.1.3 MQL5 (Silver Tier)

```
// Recommended approach
#import "VCP.dll"
   int  VCP_Initialize(string config);
   int  VCP_LogEvent(string event_json);
   void VCP_Shutdown();
#import

// Async communication pattern
void OnTimer() {
   // Process events from queue
   string event;
   while(EventQueue.Dequeue(event)) {
      VCP_LogEvent(event);
   }
}

// Critical: Use async WebRequest or DLL for non-blocking
```

7.2 Performance Requirements

7.2.1 Latency Budgets

Operation	Platinum	Gold	Silver
Event creation	<1µs	<10µs	<1ms
Serialization	<1µs	<5µs	<10ms
Hashing	<500ns	<2µs	<5ms
Signature	<5µs	<50µs	<100ms
Persistence	<5µs	<100µs	<1s
Total	<10µs	<100µs	<1s

7.2.2 Throughput Requirements

Metric	Platinum	Gold	Silver
Events/second	>1M	>100K	>1K
Batch size	1000	100	1
Queue depth	10M	1M	10K
Memory usage	<10GB	<1GB	<100MB

7.3 Error Handling

7.3.1 Error Categories

```
ErrorCategories:
  CLOCK_SYNC_FAILURE:
    Severity: CRITICAL
    Action: Degrade to UNRELIABLE status
    Recovery: Attempt resync every 60s

  HASH_CHAIN_BREAK:
    Severity: CRITICAL
    Action: Trigger VCP-RECOVERY
    Recovery: Rebuild from last anchor

  SIGNATURE_FAILURE:
    Severity: HIGH
    Action: Retry with key rotation
    Recovery: Escalate to operator

  SERIALIZATION_ERROR:
    Severity: MEDIUM
    Action: Log raw data
    Recovery: Fix and replay

  NETWORK_TIMEOUT:
    Severity: LOW
    Action: Queue for retry
    Recovery: Exponential backoff
```

---

8. Regulatory Compliance

8.1 MiFID II Compliance

Requirement	Article	VCP Implementation
Best Execution	Art. 27	VCP-TRADE (execution prices, slippage)
Algo Trading	Art. 17	VCP-GOV (algorithm identification)
Record Keeping	RTS 24	VCP-CORE (7-year retention)
Clock Synchronization	RTS 25	ClockSyncStatus field

8.2 CAT Rule 613 (US)

Requirement	VCP Implementation
Customer Account ID	AccountID (pseudonymized)
Order Trace ID	TraceID (UUID v7)
Timestamp Granularity	Nanosecond precision
Order Lifecycle	Complete event chain

8.3 GDPR Compliance

Right	Article	VCP Implementation
Erasure	Art. 17	Crypto-shredding via VCP-PRIVACY
Portability	Art. 20	JSON export capability
Rectification	Art. 16	Append-only corrections
Access	Art. 15	Filtered data export

8.4 EU AI Act Compliance

Requirement	Article	VCP Implementation
Record Keeping	Art. 12	VCP-CORE automatic logging
Risk Management	Art. 9	VCP-GOV RiskClassification, VCP-RISK
Data Governance	Art. 10	VCP-GOV AlgorithmIdentification
Transparency	Art. 13	VCP-GOV DecisionFactors
Human Oversight	Art. 14	OperatorID, LastApprovalBy

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9. Testing Requirements

9.1 Conformance Test Suite

9.1.1 Core Tests

```
CoreTests:
  - UUID_Generation:
      Verify: UUID v7 time ordering
      Iterations: 1M

  - Timestamp_Monotonicity:
      Verify: Strictly increasing timestamps
      Duration: 24 hours

  - Hash_Chain_Integrity:
      Verify: Chain validation
      Events: 10M

  - Precision_Preservation:
      Verify: String encoding for numerics
      Values: ["0.00000001", "999999999999.999999999"]
```

9.1.2 Performance Tests

```
PerformanceTests:
  Platinum:
    Throughput: ">1M events/sec"
    Latency: "p99 <10µs"
    Duration: "24 hours"

  Gold:
    Throughput: ">100K events/sec"
    Latency: "p99 <100µs"
    Duration: "8 hours"

  Silver:
    Throughput: ">1K events/sec"
    Latency: "p99 <1s"
    Duration: "1 hour"
```

9.2 Security Tests

```
SecurityTests:
  - Cryptographic_Validation:
      Algorithms: [Ed25519, ECDSA, SHA-256, SHA3-256]
      Vectors: NIST test vectors

  - Chain_Manipulation:
      Attacks: [Insertion, Deletion, Reordering, Tampering]
      Expected: All detected

  - Timing_Attacks:
      Target: Signature verification
      Requirement: Constant-time operations
```

---

10. Migration from Legacy Systems

10.1 From AUP to VCP

AUP Component	VCP Equivalent	Migration Action
AUP-CORE	VCP-CORE	Add ClockSyncStatus, HashAlgo
AUP-TRADE	VCP-TRADE	Ensure string encoding
AUP-AI + AUP-ALG	VCP-GOV	Merge and enhance
(new)	VCP-RISK	Add risk snapshots
AUP-PRIVACY	VCP-PRIVACY	Add crypto-shredding
AUP-RECOVERY	VCP-RECOVERY	Enhanced validation

10.2 Migration Strategy

```
Phase1_Parallel_Run:
  Duration: 30 days
  Mode: Shadow logging
  Validation: Compare outputs

Phase2_Gradual_Cutover:
  Duration: 30 days
  Mode: Percentage-based
  Rollback: Automatic on error

Phase3_Full_Migration:
  Validation: 99.99% compatibility
  Certification: VSO approved
```

---

11. Appendices

Appendix A: Standard Event Codes

```yaml
EventCodes:
  Trading:
    1-19: Order lifecycle
    20-29: Position management
    30-39: Risk events

  Governance:
    40-49: Algorithm updates
    50-59: Compliance events
    60-69: Audit trail

  System:
    90-99: Infrastructure
    100-109: Recovery
    110-119: Monitoring
```

Appendix B: Error Codes

```yaml
ErrorCodes:
  1xxx: Validation errors
  2xxx: Security errors
  3xxx: System errors
  4xxx: Network errors
  5xxx: Compliance errors
```

Appendix C: Timestamp Format Examples

```json
{
  "Examples": {
    "Nanosecond": 1732358400123456789,
    "Microsecond": 1732358400123456,
    "Millisecond": 1732358400123,
    "ISO8601": "2025-11-25T12:00:00.123456789Z"
  }
}
```

---

12. References

Standards

- RFC 9562: Universally Unique IDentifier (UUID) v7
- RFC 8785: JSON Canonicalization Scheme (JCS)
- RFC 6962: Certificate Transparency
- RFC 3161: Time-Stamp Protocol (TSP)
- IEEE 1588-2019: Precision Time Protocol (PTP)
- ISO 20022: Universal financial industry message scheme

Regulations

- MiFID II: Markets in Financial Instruments Directive
- RTS 24/25: Regulatory Technical Standards
- CAT Rule 613: Consolidated Audit Trail
- GDPR: General Data Protection Regulation
- EU AI Act: Artificial Intelligence Act (2024)

Cryptography

- FIPS 186-5: Digital Signature Standard
- NIST SP 800-208: Post-Quantum Cryptography
- RFC 8032: Edwards-Curve Digital Signature Algorithm (EdDSA)

Implementation

- FIX Protocol: Financial Information eXchange
- SBE: Simple Binary Encoding
- FlatBuffers: Memory Efficient Serialization Library
- Apache Kafka: Distributed Event Streaming
- Redis Streams: In-memory data structure store

Version History

Version	Date	Changes	Author

1.0	2025-11-25	Initial release with fixed Event Type codes and standardized Enum definitions	VSO Technical Committee

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- Financial industry practitioners
- Regulatory compliance experts
- Cryptography researchers
- Open-source community contributors

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End of VeritasChain Protocol (VCP) Specification v1.0