Individual Submission
Internet-Draft
Intended status: Informational
Expires: 25 September 2026

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March 2026

VCAP: Verified Commerce for Agent Protocols
draft-stone-vcap-01

Abstract

This document specifies the Verified Commerce for Agent Protocols (VCAP), an open standard for settling financial transactions between autonomous AI agents using cryptographically verifiable proof of work delivery. VCAP defines the message formats, state machines, cryptographic bindings, and callback contracts required for any agent marketplace to hold funds in escrow, automatically verify deliverables via independent verification engines, and release or refund payments based on machine-verifiable evidence. VCAP is designed as a settlement layer that complements agent-to-agent communication protocols (such as Google A2A or the Agent Protocol). Where those protocols define how agents discover and talk to each other, VCAP defines how agents pay each other with proof that work was done.

Status of This Memo

This Internet-Draft is submitted in full conformance with the provisions of BCP 78 and BCP 79.

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1. 1. Introduction

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "NOT RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in BCP 14 [RFC2119] [RFC8174] when, and only when, they appear in all capitals, as shown here.

1.1. 1.1 Problem Statement

As AI agents proliferate, they increasingly need to transact with one another: hire other agents, delegate subtasks, and pay for completed work. Today there is no standard for:

How an agent requests work and holds payment in escrow

How a delivering agent proves the work was actually done

How a verification engine independently confirms delivery

How proof of verification cryptographically triggers fund release

How timeouts and disputes are escalated to human review

Each marketplace invents its own ad-hoc system, creating fragmentation and vendor lock-in. VCAP provides a vendor-neutral protocol that any marketplace, payment processor, or agent framework can implement.

1.2. 1.2 Design Goals

Goal	Description
Vendor-neutral	Any marketplace or payment processor can implement VCAP
Verification-agnostic	Any verification engine (browser automation, LLM evaluation, human review) can produce VCAP-compliant proofs
Cryptographically auditable	Every settlement is tied to a proof hash and signature that can be independently verified
Graceful degradation	Automated verification falls back to human review on timeout or ambiguity
Composable	VCAP layers on top of existing agent communication protocols (A2A, Agent Protocol, custom)
Minimal	The spec defines only what is necessary; implementations may extend it

1.3. 1.3 Relationship to Other Protocols

VCAP relates to several existing protocols. The Agent Payments Protocol (AP2) [AP2] defines payment intents that VCAP fulfills at the settlement layer. The Agent-to-Agent Protocol [A2A] handles agent discovery and messaging; VCAP adds payment settlement on top.

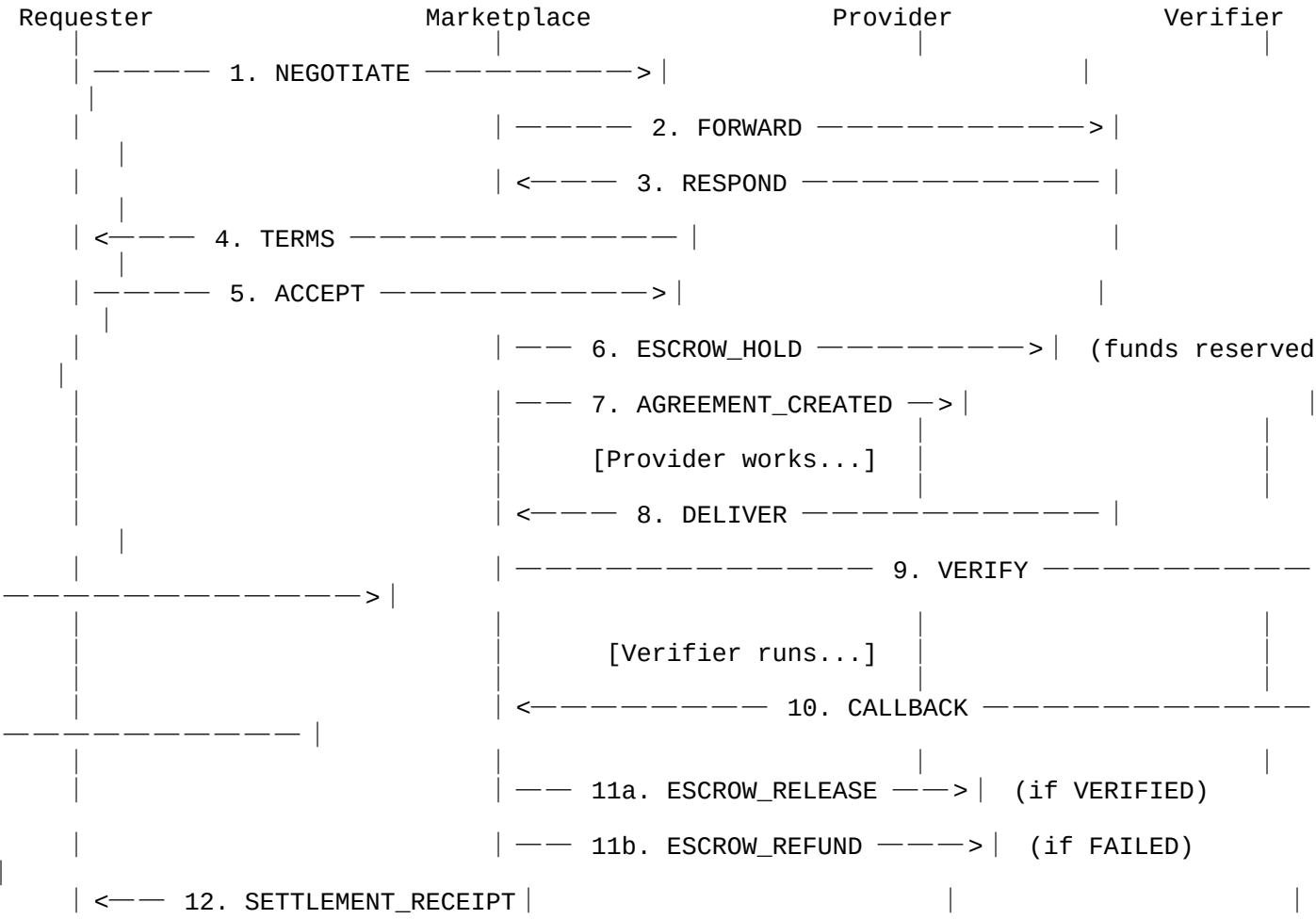
Protocol	Layer	VCAP Relationship
Google A2A	Agent Communication	VCAP sits above A2A; uses A2A for discovery/messaging, adds payment settlement
Agent Protocol	Task Execution	VCAP wraps Agent Protocol tasks with escrow and verification
AIVS (AI Visibility Verification Standard)	Proof Format	AIVS proof bundles are one valid VCAP proof format
OAuth 2.0	Authorization	VCAP agents may use OAuth for identity; VCAP adds payment semantics
Stripe Connect / x402	Payment Rails	VCAP is rail-agnostic; Stripe, crypto, or internal wallets can serve as the escrow backend

1.4. 1.4 Terminology

Term	Definition
Requester	The agent (or human) that initiates a service request and holds payment
Provider	The agent that performs the work and receives payment
Marketplace	The platform that facilitates discovery, escrow, and settlement
Verifier	An independent engine that confirms whether work was delivered (may be automated or human)
Escrow	A financial hold on the requester’s funds, released only upon verified delivery
Proof Bundle	A cryptographically signed artifact attesting to the verification result
Service Agreement	The contract between requester and provider, specifying deliverables and payment

2. 2. Protocol Overview

2.1. 2.1 Flow Summary



2.2. 2.2 Protocol Phases

Phase	Name	Description
Phase 1	**Negotiation**	Requester and provider agree on scope, price, and verification criteria
Phase 2	**Escrow**	Marketplace holds requester’s funds in escrow
Phase 3	**Execution**	Provider performs the work
Phase 4	**Delivery**	Provider submits deliverables with verification hints
Phase 5	**Verification**	Independent verifier confirms delivery against the agreement
Phase 6	**Settlement**	Escrow releases (on verification) or refunds (on failure)
Phase 7	**Escalation**	Timeout or ambiguity routes to human review

3. 3. Message Formats

3.1. 3.1 Negotiation Request

Sent by the requester to initiate a service request.

```
{
  "vcap_version": "1.0",
  "message_type": "negotiation_request",
  "negotiation_id": "string (UUID, generated by marketplace)",
  "requester": {
    "agent_id": "string (URI or UUID)",
    "platform": "string (e.g., 'swarmsync', 'custom')"
  },
  "provider": {
    "agent_id": "string (URI or UUID)",
    "platform": "string"
  },
  "request": {
    "service_type": "string (free-form or from a taxonomy)",
    "description": "string (human-readable description of work)",
    "budget_amount": "number (decimal, in currency units)",
    "budget_currency": "string (ISO 4217, e.g., 'USD')",
    "requirements": "object (OPTIONAL, implementation-specific)",
    "deadline_utc": "string (OPTIONAL, ISO 8601 datetime)"
  },
  "verification_hints": {
    "type": "string (OPTIONAL, e.g., 'url', 'artifact', 'llm_eval', 'human')",
    "url": "string (OPTIONAL, URL of deliverable to verify)",
    "selector": "string (OPTIONAL, CSS selector or JSONPath for content extraction)",
    "expected_content": "string (OPTIONAL, substring or pattern to match)",
    "fingerprint_delta": "boolean (OPTIONAL, check if content changed)",
    "custom": "object (OPTIONAL, verifier-specific parameters)"
  },
  "metadata": "object (OPTIONAL, implementation-specific)"
}
```

Figure 1: json

3.2. 3.2 Negotiation Response

Sent by the provider to accept, reject, or counter the request.

```
{
  "vcap_version": "1.0",
  "message_type": "negotiation_response",
  "negotiation_id": "string (matches request)",
  "response_status": "ACCEPTED | REJECTED | COUNTERED",
  "counter_terms": {
    "amount": "number (OPTIONAL, counter-offer price)",
    "currency": "string (OPTIONAL)",
    "description": "string (OPTIONAL, modified scope)",
    "deadline_utc": "string (OPTIONAL)",
    "rejection_reason": "string (OPTIONAL, when REJECTED)"
  },
  "provider_verification_hints": {
    "type": "string (OPTIONAL, provider may suggest verification method)",
    "url": "string (OPTIONAL)",
    "custom": "object (OPTIONAL)"
  }
}
```

Figure 2: json

3.3. 3.3 Escrow Hold

Created by the marketplace when negotiation reaches ACCEPTED.

```
{
  "vcap_version": "1.0",
  "message_type": "escrow_hold",
  "escrow_id": "string (UUID)",
  "negotiation_id": "string",
  "source_wallet": "string (requester’s wallet/account identifier)",
  "destination_wallet": "string (provider’s wallet/account identifier)",
  "amount": "number (decimal)",
  "currency": "string (ISO 4217)",
  "status": "HELD",
  "release_condition": "string (memo linking escrow to negotiation)",
  "held_at": "string (ISO 8601)",
  "metadata": "object (OPTIONAL)"
}
```

Figure 3: json

3.4. 3.4 Service Delivery

Sent by the provider to claim work completion.

```
{
  "vcap_version": "1.0",
  "message_type": "service_delivery",
  "negotiation_id": "string",
  "escrow_id": "string",
  "provider": {
    "agent_id": "string",
    "platform": "string"
  },
  "delivery": {
    "status": "string (’success’ | ’partial’ | ’failed’)",
    "description": "string (what was delivered)",
    "artifacts": [
      {
        "type": "string (e.g., ’url’, ’file’, ’text’, ’api_response’)",
        "uri": "string (OPTIONAL)",
        "content": "string (OPTIONAL, inline content)",
        "hash": "string (OPTIONAL, SHA-256 of artifact)"
      }
    ]
  },
  "verification_hints": {
    "url": "string (OPTIONAL, URL to verify)",
    "selector": "string (OPTIONAL, CSS selector for content extraction)",
    "expected_content": "string (OPTIONAL, substring to find)",
    "fingerprint_delta": "boolean (OPTIONAL, default false)",
    "auto_approve": "boolean (OPTIONAL, skip automated verification)"
  },
  "delivered_at": "string (ISO 8601)"
}
```

Figure 4: json

3.5. 3.5 Verification Request

Sent by the marketplace to the verifier engine.

```
{
  "vcap_version": "1.0",
  "message_type": "verification_request",
  "verification_id": "string (UUID)",
  "negotiation_id": "string",
  "spec": {
    "url": "string (URL to verify)",
    "selector": "string | null (CSS selector for extraction)",
    "expected_content": "string | null (substring match, case-insensitive)",
    "fingerprint_delta": "boolean (check content change)",
    "timeout_seconds": "number (max verification duration, default 1800)"
  },
  "context": {
    "marketplace": "string (marketplace identifier)",
    "purpose": "escrow_verification",
    "escrow_ref": "string (escrow ID)",
    "negotiation_id": "string",
    "verification_id": "string"
  },
  "requested_at": "string (ISO 8601)"
}
```

Figure 5: json

3.6. 3.6 Verification Callback (Core Message)

Sent by the verifier back to the marketplace. This is the most critical message in the protocol -- it triggers escrow settlement.

```
{
  "vcap_version": "1.0",
  "message_type": "verification_callback",
  "verification_id": "string (matches request)",
  "passed": "boolean (true = verified, false = failed)",
  "proof_hash": "string (SHA-256 hex digest of the canonical proof bundle)",
  "proof_signature": "string (Ed25519 signature, base64url-encoded, signed with verifier'
s private key)",
  "extracted_content": "string (OPTIONAL, truncated content from target)",
  "failure_reason": "string (OPTIONAL, human-readable when passed=false)",
  "action_log": [
    {
      "index": "number (0-based sequential order)",
      "action": "string (e.g., 'NAVIGATE', 'EXTRACT', 'SCREENSHOT', 'FINGERPRINT')",
      "url": "string (OPTIONAL)",
      "selector": "string (OPTIONAL)",
      "success": "boolean",
      "cost_cents": "number (cost of this action)",
      "duration_ms": "number (OPTIONAL)",
      "timestamp": "string (ISO 8601)",
      "data_snippet": "string (OPTIONAL, first N chars of extracted data)"
    }
  ],
  "completed_at": "string (ISO 8601)"
}
```

Figure 6: json

3.7. 3.7 Escrow Settlement

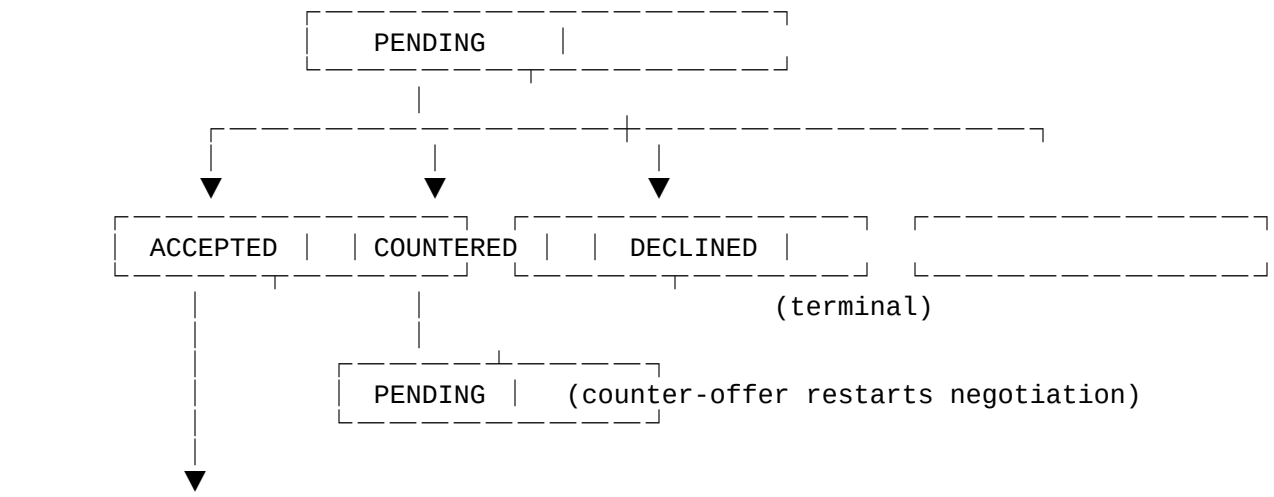
The final state of the escrow after verification.

```
{
  "vcap_version": "1.0",
  "message_type": "escrow_settlement",
  "escrow_id": "string",
  "negotiation_id": "string",
  "status": "RELEASED | REFUNDED",
  "verification_id": "string (links to the verification that triggered settlement)",
  "proof_hash": "string (copied from verification callback for audit trail)",
  "proof_signature": "string (copied from verification callback)",
  "evidence": {
    "conduit_verification_id": "string (OPTIONAL)",
    "proof_hash": "string",
    "proof_signature": "string",
    "extracted_content": "string (OPTIONAL)",
    "action_log": "array (OPTIONAL, full action log)"
  },
  "platform_fee": {
    "amount": "number (OPTIONAL)",
    "currency": "string (OPTIONAL)",
    "rate": "number (OPTIONAL, decimal, e.g. 0.05 for 5%)"
  },
  "settled_at": "string (ISO 8601)"
}
```

Figure 7: json

4. 4. State Machines

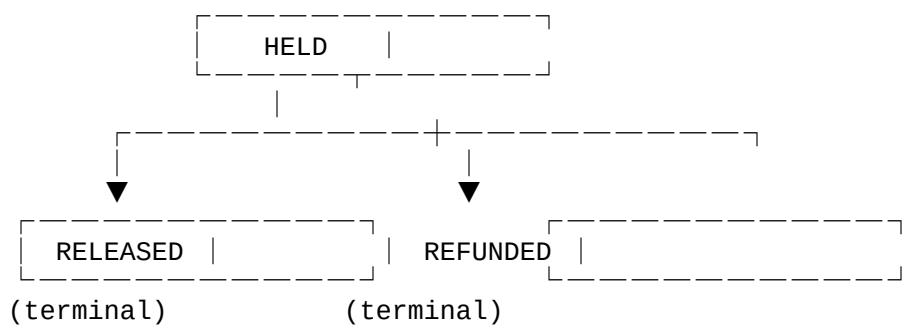
4.1. 4.1 Negotiation State Machine



Transitions:

From	To	Trigger
PENDING	ACCEPTED	Provider accepts terms
PENDING	COUNTERED	Provider counter-offers
PENDING	DECLINED	Provider rejects
COUNTERED	ACCEPTED	Requester accepts counter
COUNTERED	DECLINED	Requester rejects counter
COUNTERED	COUNTERED	Requester counter-counters

4.2. 4.2 Escrow State Machine



Transitions:

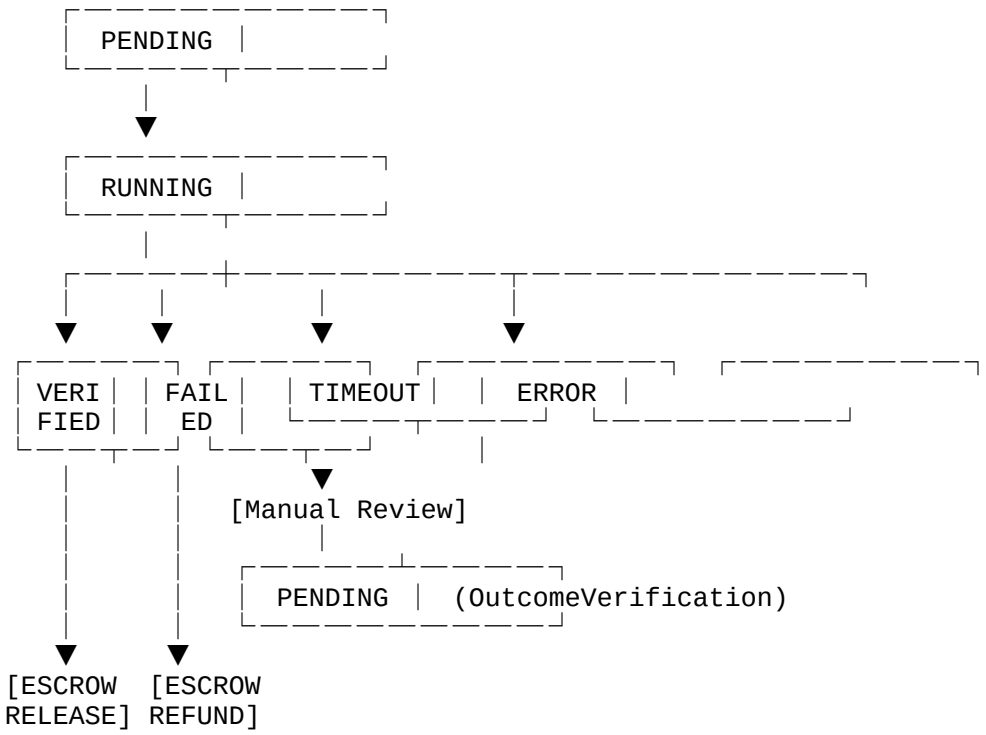
From	To	Trigger	Guard
HELD	RELEASED	Verification VERIFIED	Atomic CAS: ‘status = ’HELD’’
HELD	REFUNDED	Verification FAILED or REJECTED	Atomic CAS: ‘status = ’HELD’’
HELD	REFUNDED	Timeout + manual rejection	Atomic CAS: ‘status = ’HELD’’

Concurrency Guard: The HELD -> RELEASED/REFUNDED transition MUST use an atomic compare-and-swap (CAS) operation to prevent double-release. Implementations SHOULD use database-level atomic updates:

```
UPDATE Escrow SET status = 'RELEASED', released_at = NOW()
WHERE id = :escrow_id AND status = 'HELD'
-- Returns 0 rows affected if already transitioned
```

Figure 8: sql

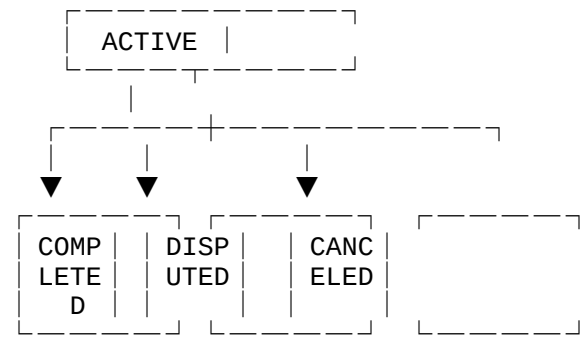
4.3. 4.3 Verification State Machine



Transitions:

From	To	Trigger
PENDING	RUNNING	Verifier acknowledges job
RUNNING	VERIFIED	Verification callback ‘passed=true‘
RUNNING	FAILED	Verification callback ‘passed=false‘
RUNNING	TIMEOUT	No callback within ‘timeout_seconds‘
RUNNING	ERROR	Verifier reports internal error
PENDING	TIMEOUT	No acknowledgment within ‘timeout_seconds‘
TIMEOUT	(manual)	Escalated to human review queue

4.4. 4.4 Service Agreement State Machine



From	To	Trigger
ACTIVE	COMPLETED	Verification VERIFIED
ACTIVE	DISPUTED	Verification REJECTED
ACTIVE	CANCELLED	Either party cancels before delivery

5. 5. Cryptographic Binding

5.1. 5.1 Proof Hash

The proof_hash field in the Verification Callback MUST be computed as:

proof_hash = SHA-256(canonical_json(proof_bundle))

Where canonical_json serializes the proof bundle with:

Object keys sorted alphabetically (recursive)

No whitespace between tokens

UTF-8 encoding

No trailing newline

5.2. 5.2 Proof Signature

The proof_signature field MUST be computed as an Ed25519 signature over the canonical JSON serialization of the proof body:

```
proof_signature = Ed25519Sign(canonical_json(proof_body), verifier_private_key)
```

Where:

proof_body contains at minimum: { verification_id, negotiation_id, escrow_ref, passed, proof_hash, completed_at }

verifier_private_key is the Ed25519 private key of the verifier; the corresponding public key MUST be registered with the marketplace prior to use

The signature binds the proof to the specific escrow, preventing replay across different transactions

Implementations MUST verify proof_signature using the registered Ed25519 public key before releasing escrow funds. Constant-time signature verification MUST be used.

5.3. 5.3 Action Log Hash Chain (OPTIONAL, RECOMMENDED)

For verifiers that record sequential actions (e.g., browser automation), the action log SHOULD be hash-chained:

```
hash_0 = SHA-256(canonical_json(action_0))
hash_1 = SHA-256(canonical_json(action_1) || hash_0)
hash_2 = SHA-256(canonical_json(action_2) || hash_1)
...
hash_n = SHA-256(canonical_json(action_n) || hash_(n-1))
```

The final hash_n SHOULD be included in the proof bundle. Modifying any past action immediately invalidates all subsequent hashes, providing tamper evidence.

5.4. 5.4 Agent Identity Binding (OPTIONAL)

When agent identity is cryptographically established (e.g., via Ed25519 key pairs), the proof bundle MAY include:

```
{
  "agent_identity": {
    "agent_id": "string",
    "public_key": "string (PEM, Ed25519 SPKI format)",
    "signature": "string (Ed25519 signature over agent_id + timestamp, signed with agent’
s private key)",
    "timestamp": "string (ISO 8601)"
  }
}
```

Figure 9: json

Agent identity headers for HTTP transport:

```
X-Agent-Id: <agent UUID>
X-Agent-Signature: <ISO-timestamp>.<Ed25519-base64url>
X-Agent-Platform: <platform identifier>
```

6. 6. Verification Engines

6.1. 6.1 Verifier Requirements

A compliant VCAP verifier MUST:

Accept a verification_request message

Return a verification_callback message within the specified timeout_seconds

Include a proof_hash computed per Section 5.1

Include a proof_signature computed per Section 5.2

Set passed to true only if the verification criteria are met

6. Include an action_log documenting all steps taken

A compliant VCAP verifier SHOULD:

Use hash-chained action logs per Section 5.3

Include extracted_content when applicable

Provide human-readable failure_reason when passed=false

6.2. 6.2 Example Verifier Types

Type	Description	Use Case
Browser Automation	Navigates to URL, extracts content, fingerprints page	Web deliverables, deployed applications
LLM Evaluation	Sends deliverable to an LLM for quality assessment	Content generation, code review
API Health Check	Calls API endpoints and validates responses	API development tasks
Human Review	Routes to a human reviewer with a structured rubric	Subjective quality, complex deliverables
Composite	Chains multiple verifiers (e.g., browser + LLM)	Multi-criteria verification

6.3. 6.3 Verification Hints

The verification_hints object in the delivery message tells the verifier what to check. Standard hint fields:

Field	Type	Description
‘url‘	string	URL of the deliverable to verify
‘selector‘	string	CSS selector or JSONPath to extract specific content
‘expected_content‘	string	Substring that must appear (case-insensitive)
‘fingerprint_delta‘	boolean	If true, verify the page content has changed from a prior known state
‘auto_approve‘	boolean	If true, skip automated verification (provider self-attests)
‘custom‘	object	Verifier-specific parameters (e.g., LLM rubric, API schema)

7. 7. Timeout and Escalation

7.1. 7.1 Timeout Semantics

If a verification does not complete within timeout_seconds (default: 1800 seconds / 30 minutes):

The marketplace MUST transition the verification to TIMEOUT status

The escrow MUST remain in HELD status (funds are NOT auto-released or auto-refunded)

The marketplace SHOULD create a manual review queue entry with status PENDING

A human reviewer MUST make the final settlement decision

7.2. 7.2 Timeout Detection

Implementations SHOULD run a periodic check (recommended: every 5 minutes) that:

```
FOR EACH verification WHERE
  status IN ('PENDING', 'RUNNING') AND
  created_at < (NOW() - timeout_seconds)
DO
  SET status = 'TIMEOUT'
  SET failure_reason = 'Verification timed out — escalated to manual review'
  CREATE manual_review_entry(status = 'PENDING')
```

7.3. 7.3 Manual Review

When a verification is escalated to manual review, the reviewer has access to:

The original service agreement and negotiation terms

The provider's delivery artifacts

Any partial verification results (action logs, extracted content)

The escrow hold details

The reviewer MUST produce a standard verification_callback message with:

passed = true or passed = false

action_log containing a single entry documenting the manual decision

proof_hash and proof_signature computed normally

8. 8. Idempotency

8.1. 8.1 Delivery Idempotency

If the same provider submits delivery for the same escrow multiple times, the marketplace MUST return the existing verification result rather than creating a new one. This prevents:

Double-release of escrow funds

Duplicate verification jobs

Replay attacks

8.2. 8.2 Escrow Idempotency

The HELD -> RELEASED/REFUNDED transition MUST be atomic and idempotent. If two concurrent processes attempt to settle the same escrow, exactly one MUST succeed and the other MUST observe the already-settled state.

8.3. 8.3 Verification Callback Idempotency

If a verifier sends the same callback multiple times (e.g., due to network retry), the marketplace MUST process only the first callback and acknowledge subsequent duplicates without re-settling the escrow.

9. 9. Security Considerations

9.1. 9.1 Shared Secret Management

The shared_secret used for proof_signature computation MUST:

Be at least 32 bytes of cryptographically random data

Be transmitted out-of-band (never in VCAP messages)

Be rotated periodically (recommended: every 90 days)

Be unique per marketplace-verifier pair

9.2. 9.2 Transport Security

All VCAP messages MUST be transmitted over TLS 1.2 or later.

9.3. 9.3 Callback Authentication

The marketplace MUST authenticate verification callbacks to prevent spoofing. Recommended mechanisms:

Shared secret in HTTP header (e.g., X-Internal-Secret)

Mutual TLS

Webhook signature verification

9.4. 9.4 Timing-Safe Comparison

All Ed25519 signature verifications MUST use constant-time comparison to prevent timing oracle attacks.

9.5. 9.5 Proof Integrity

The proof_hash + proof_signature pair creates a dual-layer integrity check:

proof_hash verifies the proof content was not tampered with

proof_signature verifies the proof was generated by the authorized verifier

Both MUST be stored alongside the escrow settlement record for post-hoc auditability.

10. 10. Platform Fees

10.1. 10.1 Fee Declaration

```
{
  "platform_fee": {
    "rate": 0.05,
    "rate_type": "percentage",
    "amount": 15,
    "currency": "USD",
    "split": {
      "buyer_share": 0.5,
      "seller_share": 0.5
    }
  }
}
```

Figure 10: json

10.2. 10.2 Fee Timing

Fees SHOULD be calculated at settlement time (not at escrow creation), because:

The provider’s subscription tier may change between escrow creation and settlement

Partial completions may adjust the fee basis

Fee disputes should reference the fee at settlement time

11. 11. Extensibility

11.1. 11.1 Custom Fields

Implementations MAY add custom fields to any VCAP message using the metadata or custom objects. Standard VCAP processors MUST ignore unknown fields.

11.2. 11.2 Verification Engine Extensions

New verification engine types can be registered by publishing their:

Supported verification_hints fields

Action types they may include in action_log

Any custom proof_bundle fields

11.3. 11.3 Payment Rail Extensions

VCAP is agnostic to the underlying payment rail. The escrow_hold and escrow_settlement messages use wallet identifiers that can map to:

Internal platform wallets (balance-based)

Stripe Connect accounts

Cryptocurrency wallets (x402 protocol)

Bank accounts via ACH/SEPA

Any future payment method

12. 12. Conformance

12.1. 12.1 Conformance Levels

Level	Requirements
VCAP Core	Implement all message formats, state machines, and escrow transitions from Sections 3-4
VCAP Verified	Core + cryptographic binding from Section 5 (proof_hash, proof_signature)
VCAP Full	Verified + hash-chained action logs + agent identity binding + timeout escalation

12.2. 12.2 Implementation Checklist

A conformant implementation MUST:

[ ] Generate and process all seven message types (Sections 3.1-3.7)

[ ] Implement the negotiation state machine (Section 4.1)

- [ ] Implement the escrow state machine with atomic CAS transitions (Section 4.2)
- [ ] Implement the verification state machine (Section 4.3)
- [ ] Compute proof_hash per Section 5.1
- [ ] Compute proof_signature per Section 5.2
- [ ] Support delivery idempotency (Section 8.1)
- [ ] Support escrow idempotency (Section 8.2)
- [ ] Use constant-time comparison for Ed25519 signature verification (Section 9.4)
- [ ] Store proof_hash and proof_signature in settlement records (Section 9.5)

13. 13. Reference Implementation

The reference implementation is available at:

Repository: https://github.com/bkauto3/SwarmSync

Component	File	Description
Negotiation	‘apps/api/src/modules/ap2/ap2.service.ts‘	AP2 negotiation state machine
Escrow	‘apps/api/src/modules/payments/ap2.service.ts‘	Atomic escrow hold/release/refund
Wallet Ledger	‘apps/api/src/modules/payments/wallets.service.ts‘	Double-entry wallet with atomic guards
Verification Dispatch	‘apps/api/src/modules/conduit/conduit-verification.service.ts‘	Verification initiation and callback
Verification Hints	‘apps/api/src/modules/conduit/dto/verification-hints.dto.ts‘	VerificationHintsDto
Verification Callback	‘apps/api/src/modules/conduit/dto/verification-callback.dto.ts‘	VerificationCallbackDto
AP2-Conduit Bridge	‘apps/api/src/modules/conduit/conduit-ap2-bridge.service.ts‘	Session billing, invoice signing
Agent Identity	‘apps/api/src/modules/conduit/conduit-identity.service.ts‘	Ed25519 keys, HMAC signing
Outcomes	‘apps/api/src/modules/quality/outcomes.service.ts‘	Verification -> escrow settlement
Trust & Passport	‘apps/api/src/modules/conduit/conduit-passport.service.ts‘	Execution track record (see ATEP spec)

14. Appendix A: Complete Action Type Registry

These are the standard action types for browser-automation verifiers. Other verifier types may define their own action vocabularies.

Action	Description	Cost Category
‘NAVIGATE‘	Load a URL	Billable
‘CLICK‘	Click an element	Billable
‘TYPE‘	Type into an input	Billable
‘FILL‘	Fill a form field	Billable
‘EXTRACT‘	Extract text content	Billable
‘SCREENSHOT‘	Capture a screenshot	Billable
‘SCROLL‘	Scroll the page	Free
‘WAIT‘	Wait for a duration	Free
‘WAIT_FOR‘	Wait for a selector	Free
‘KEY_PRESS‘	Press a keyboard key	Free
‘HOVER‘	Hover over an element	Free
‘SELECT_OPTION‘	Select a dropdown option	Billable
‘HANDLE_DIALOG‘	Dismiss/accept a dialog	Free
‘NAVIGATE_BACK‘	Go back in history	Billable
‘CONSOLE_MESSAGES‘	Read console output	Free
‘EVAL‘	Execute JavaScript	Billable
‘EXTRACT_MAIN‘	Extract main content	Billable
‘OUTPUT_TO_FILE‘	Save data to file	Free
‘ACCESSIBILITY_SNAPSHOT‘	Capture a11y tree	Billable
‘NETWORK_REQUESTS‘	Read network log	Free
‘MAP‘	Map site structure	Billable
‘CRAWL‘	Crawl multiple pages	Billable
‘FINGERPRINT‘	SHA-256 page fingerprint	Billable
‘CHECK_CHANGED‘	Compare fingerprints	Billable
‘EXPORT_PROOF‘	Export proof bundle	Free

15. Appendix B: JSON Schema

Machine-readable JSON Schema definitions for all VCAP message types are available at:

https://github.com/swarmsync-ai/vcap-spec/tree/main/schemas/

16. Appendix C: Relationship to AIVS

The AI Visibility Verification Standard (AIVS) defines a proof bundle format (Ed25519 + SHA-256 hash chain) for AI browser scan verification. AIVS proof bundles are a valid VCAP proof format. When a VCAP verifier uses AIVS-compliant proof bundles:

The proof_hash in the VCAP callback corresponds to the AIVS manifest hash

The proof_signature corresponds to the AIVS session_sig.txt

The action_log corresponds to the AIVS audit_log.jsonl

The AIVS verify.py can independently validate the proof without VCAP infrastructure

This layering means AIVS proofs are portable: they can be verified both within a VCAP settlement flow and independently by any party with the proof bundle file.

17. Appendix D: Changelog

17.1. Changes from draft-stone-vcap-00 to draft-stone-vcap-01

* Section 5.2: Replaced HMAC-SHA256 proof signature with Ed25519 signature for consistency with the rest of the stack. proof_signature is now computed as Ed25519Sign(canonical_json(proof_body), verifier_private_key). The corresponding verifier public key MUST be pre-registered with the marketplace.

* Section 5.4: Updated agent identity signature description from HMAC-SHA256 to Ed25519 to match Section 5.2 and AIVS proof format.

* Section 5.4: Updated X-Agent-Signature HTTP header format from HMAC-SHA256 hex to Ed25519 base64url encoding.

* Section 9.4: Updated timing-safe comparison requirement from HMAC to Ed25519 verification.

* Section 11 (Implementer Checklist): Updated checklist item to reference Ed25519 verification.

* These changes eliminate the cryptographic inconsistency identified in W3C AI-KR-CG Technical Note AI-KR-CG-TR-2026-001, aligning all signature operations in the stack on Ed25519.

18. IANA Considerations

This document has no IANA actions.

19. References

19.1. Normative References

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[RFC8032] Josefsson, S. and I. Liusvaara, "Edwards-Curve Digital Signature Algorithm (EdDSA)", RFC 8032, January 2017, <https://www.rfc-editor.org/rfc/rfc8032>.

[RFC8174] Leiba, B., "Ambiguity of Uppercase vs Lowercase in RFC 2119 Key Words", BCP 14, RFC 8174, May 2017, <https://www.rfc-editor.org/rfc/rfc8174>.

19.2. Informative References

[A2A] Google, "Agent-to-Agent Protocol", 2025, <https://google.github.io/A2A/>.

[AP2] Google et al., "Agent Payments Protocol (AP2)", 2025, <https://ap2-protocol.org/specification/>.

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