

# **Bundle Protocol v7 / DTN (NASA ION) vs a memory-native protocol: where do trust, policy, and consensus live?**

Bundle Protocol version 7 (RFC 9171) and the DTN stack implemented in NASA's Interplanetary Overlay Network (ION) solve delay-tolerant delivery: they store, carry, and forward self-contained bundles across links that are never simultaneously connected. This article looks at a different axis from delivery, namely where verifiable lineage, governance policy, and mutation consensus reside as data crosses trust boundaries. That axis is addressed by the Memory-Native Protocol, disclosed in United States Patent Application 19/366,760.

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## **What Bundle Protocol v7 / DTN (NASA ION) Does**

Bundle Protocol version 7, standardized as RFC 9171 by the IETF Delay-Tolerant Networking working group, is an overlay protocol built for networks where end-to-end paths may never exist at a single moment in time. Instead of assuming a continuous connection like TCP/IP, it uses a store-carry-forward model: a node accepts a bundle, holds it in persistent storage until a viable next hop appears, and then forwards it onward. This tolerates the long, variable, and often one-way delays that characterize deep-space links, disrupted tactical networks, and intermittently connected sensor fields.

NASA's Interplanetary Overlay Network (ION) is a widely respected, flight-proven implementation of this family of protocols. It has operated on spacecraft and has been exercised aboard the International Space Station, and it is engineered for the severe constraints of interplanetary communication: scheduled contacts, extreme propagation latency, and constrained onboard resources. ION and the broader DTN stack include mature, carefully designed mechanisms such as contact graph routing, which plans forwarding across a schedule of known future link opportunities, and the Bundle Protocol Security extensions (BPsec), which provide integrity and confidentiality blocks for bundle contents.

These are substantial, hard-won strengths. Bundle Protocol v7 and ION represent decades of engineering focused on getting data to survive and arrive across hostile, disconnected links. Any fair comparison starts by acknowledging that delay-tolerant delivery is a genuinely difficult problem and that this stack solves it well.

## **The Architectural Axis**

The relevant axis here is not whether data arrives across a broken link. Both approaches embrace store-carry-forward and both treat the transported object as self-contained. The axis is what the transported object is authoritative for once it arrives.

In the Bundle Protocol model, a bundle is fundamentally a delivery container. It carries a payload, a primary block with source and destination endpoint identifiers, and optional extension and security blocks. Routing decisions, such as contact graph routing, are computed by the node from network topology and contact schedules. Governance concerns such as who may act on the payload, under what policy, and how a change to shared state gets agreed upon are, by design, left to the applications and to operational configuration layered above the protocol. Security blocks under BPsec protect the integrity and confidentiality of blocks, but the protocol's job ends at faithful,

secured delivery; it does not attempt to make the bundle carry its own governance rules, its own routing eligibility logic, or a consensus procedure for mutating shared state.

That is a reasonable and deliberate scoping decision for a delivery protocol. It does, however, leave a structural question open: when data moves across administrative and trust boundaries with no continuous connectivity and no shared, synchronized authority, where do lineage, policy, and consensus live?

## **How the Disclosed Approach Differs**

The Memory-Native Protocol disclosed in United States Patent Application 19/366,760 answers that question by making the transported object the authoritative site of governance rather than only of delivery. In this disclosure, the unit of transmission is an agent: a cryptographically signed object that carries a unique identifier, a payload, a transport header, a memory field, and a signature. The memory field is an append-only record containing verifiable lineage, access logs, and policy references, and each entry is signed by the contributing node and chained by cryptographic hash to preserve ordering and auditability.

Because governance context travels inside the object, the protocol stack at each node consults the memory field before acting. The disclosure describes a horizontally composable stack whose behavior is determined by metadata embedded in the received agent. A dynamic routing protocol scores next hops using trust signals extracted from the agent's memory and transport header rather than from address tables alone, so routing is trust-scoped: a path can be favored or suppressed based on the agent's own access history and embedded policy boundaries. An adaptive consensus protocol lets nodes evaluate a mutation proposal carried in the agent and form a quorum whose eligibility, weighting, and threshold are defined by the policy references embedded in the agent's memory field. As the disclosure puts it, quorum is dynamically scoped from

agent-resident policy rather than from a fixed validator set or a globally synchronized ledger, and consensus can be scoped entirely to the identity, memory, and mutation context of a single agent.

Critically for disconnected operation, the disclosure states that these evaluations run using only the information embedded in the agent, without external session verification or off-chain lookup, which it identifies as what enables secure operation in intermittently connected networks. Nodes may run in stateless mode, deriving all routing, consensus, and propagation decisions solely from the received agent. The substrate is described as deployable over delay-tolerant networking and mesh transports, among others, so it does not replace store-carry-forward; it rides above whatever transport is available and adds a governance layer to the object itself.

In short, the difference on this axis is placement. Bundle Protocol v7 secures and delivers a self-contained container and leaves policy and consensus to layers above. The disclosed approach embeds verifiable lineage, policy references, and a trust-scoped routing and quorum procedure inside the object, so that the rules travel with the data.

## **Where They Fit Together**

These two things are more naturally complementary than competitive, and the disclosure is explicit that its substrate operates above the transport layer and can be carried over delay-tolerant networking. That framing means Bundle Protocol v7 and ION can serve as the delivery fabric, providing the store-carry-forward retention, scheduled-contact routing, and flight-proven resilience that they are built for, while agents in the disclosed model are the objects being carried.

Read that way, the composition is clean: the Bundle Protocol answers how an object survives and reaches a node across a disconnected link, and the disclosed memory-native layer answers what that object is allowed to do, who may mutate it, and how a change is agreed upon once it arrives, all without a live session or a shared ledger. An

operator who already trusts ION for interplanetary or disrupted-network delivery would not have to abandon it to gain agent-resident governance; the disclosure positions its stack as deployable incrementally over existing transports, including delay-tolerant ones, and interoperable with legacy clients through dual-mode deployments.

## **Boundary Conditions**

Honesty about limits matters on both sides. Bundle Protocol v7 and ION are mature, standardized, and operationally validated in demanding environments; that track record is real and is not something the disclosed approach claims to match. The Memory-Native Protocol is described in a patent application, which is a disclosure of an architecture rather than a report of a fielded, flight-qualified system, and this article deliberately avoids attributing any performance figures or benchmarks to it beyond what the specification states about its mechanisms.

There are also intrinsic costs to embedding governance in the object. An append-only, hash-chained memory field that accumulates signed lineage and traces grows as an agent traverses many nodes, and validating signatures and resolving policy references at each hop is work that a pure delivery container does not incur. The disclosure addresses resource-constrained participation with stateless and memory-light node modes and with optional layers that can be omitted, but the general tradeoff is that carrying more context in the object is not free. Whether that tradeoff is worthwhile depends on whether the deployment actually needs cross-boundary trust and consensus, or only needs reliable delivery, in which case a delivery-focused protocol is the simpler and better-proven fit.

## Disclosure Scope

The mechanisms attributed to the disclosed approach in this article are those set out in United States Patent Application 19/366,760, and only claims traceable to that specification are made about it. The descriptions of Bundle Protocol version 7, RFC 9171, delay-tolerant networking, and NASA's Interplanetary Overlay Network are provided as external context to locate the disclosure within a familiar landscape; they are architecture-level, publicly known characterizations offered neutrally and are not part of, or a representation by, the filing. Nothing here should be read as asserting that Bundle Protocol v7, DTN, or ION is defective; those systems are well engineered for the delivery problem they target. The comparison is confined to a single structural axis, namely where verifiable lineage, embedded policy, and trust-scoped consensus reside, and it is offered to clarify what the disclosed invention structurally provides on that axis, not to disparage any other system.

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## **Memory-Native Protocol** (</memory-native-protocol>) [All 40 steps → \(/inventive-steps\)](/inventive-steps)

Authority intrinsic to the object. Routing by semantic properties.

[U.S. 19/366,760 \(/patents/19-366760\)](/patents/19-366760)

### **PRIMARY TECHNICAL DISCLOSURE**

- [Memory-Native Networking: A Cognition-Compatible Protocol Substrate \(/articles/memory-native-networking-a-cognition-compatible-protocol-substrate\)](/articles/memory-native-networking-a-cognition-compatible-protocol-substrate)

### **SECONDARY TECHNICAL**

- [Protocol-Native Carriers: Agents as the Fundamental Unit of Transmission \(/articles/memory-native-protocol/protocol-native-carrier\)](/articles/memory-native-protocol/protocol-native-carrier)
- [Dynamic Routing Protocol: Memory-Aware Path Selection for Semantic Agents \(/articles/memory-native-protocol/dynamic-routing\)](/articles/memory-native-protocol/dynamic-routing)

- [Trust-Weighted Route Scoring: Dynamic Path Selection Through Policy-Defined Trust Thresholds \(/articles/memory-native-protocol/trust-weighted-routing\)](/articles/memory-native-protocol/trust-weighted-routing)
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- [Health Agents as Semantic Objects: Operational Metrics That Route Like Any Other Agent \(/articles/memory-native-protocol/health-agents\)](/articles/memory-native-protocol/health-agents)
- [Dynamic Indexing Protocol: Entropy-Driven Restructuring of Semantic Flows \(/articles/memory-native-protocol/dynamic-indexing\)](/articles/memory-native-protocol/dynamic-indexing)
- [Soft-Index Anchors: Ephemeral Index Points Inferred From Agent Lineage \(/articles/memory-native-protocol/soft-index-anchors\)](/articles/memory-native-protocol/soft-index-anchors)
- [Adaptive Consensus Protocol: Memory-Native Quorum Without Fixed Validator Sets \(/articles/memory-native-protocol/adaptive-consensus\)](/articles/memory-native-protocol/adaptive-consensus)
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- [Dynamic Alias Resolution: Zone-Local Semantic Aliases Resolved Through Transport Headers \(/articles/memory-native-protocol/alias-resolution\)](/articles/memory-native-protocol/alias-resolution)
- [Horizontally Composable Protocol Stack: Independent Layers Operating in Parallel \(/articles/memory-native-protocol/composable-stack\)](/articles/memory-native-protocol/composable-stack)
- [Transport-Layer Agnosticism: One Protocol Stack Above Any Carrier \(/articles/memory-native-protocol/transport-agnosticism\)](/articles/memory-native-protocol/transport-agnosticism)
- [Federated Semantic Zone Deployment: Heterogeneous Nodes Coordinating Across Trust Boundaries \(/articles/memory-native-protocol/federated-zones\)](/articles/memory-native-protocol/federated-zones)
- [Health-Triggered Quorum Adjustment: Dynamic Thresholds From Network Stability Signals \(/articles/memory-native-protocol/health-triggered-quorum\)](/articles/memory-native-protocol/health-triggered-quorum)
- [The Agent Is the Wire Format: A Self-Contained Unit on the Network \(/articles/memory-native-protocol/governed-mesh-wire-format\)](/articles/memory-native-protocol/governed-mesh-wire-format)
- [Hop-History Relay and In-Band Chain of Custody \(/articles/memory-native-protocol/hop-history-relay\)](/articles/memory-native-protocol/hop-history-relay)
- [Mobile Store-and-Forward Without Cellular Backhaul \(/articles/memory-native-protocol/mobile-store-and-forward\)](/articles/memory-native-protocol/mobile-store-and-forward)

## **APPLICATIONS · GENERAL**

- [A Memory-Native Coordination Fabric for Multi-Agent AI Orchestration \(/articles/memory-native-protocol/multi-agent-orchestration-fabric\)](/articles/memory-native-protocol/multi-agent-orchestration-fabric)
- [Edge Routing Without a Central Control Plane: Compliance-Grade Routing Authority at the Edge \(/articles/memory-native-protocol/edge-routing\)](/articles/memory-native-protocol/edge-routing)
- [Broker-Free IoT Device Mesh Governance at Scale \(/articles/memory-native-protocol/iot-mesh\)](/articles/memory-native-protocol/iot-mesh)

- [V2V Communication Without Roadside Infrastructure: Memory-Native Trust for Autonomous Vehicles \(/articles/memory-native-protocol/autonomous-vehicle-networking\)](/articles/memory-native-protocol/autonomous-vehicle-networking).
- [Military Mesh Networks Without Central Routing Authority \(/articles/memory-native-protocol/military-mesh-networks\)](/articles/memory-native-protocol/military-mesh-networks).
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- [Contested-Mesh Radio for Defense and Public Safety \(/articles/memory-native-protocol/contested-mesh-radio\)](/articles/memory-native-protocol/contested-mesh-radio).
- [Expeditionary Mesh for GNSS-Denied Operations \(/articles/memory-native-protocol/expeditionary-mesh\)](/articles/memory-native-protocol/expeditionary-mesh).
- [Maritime, Agricultural, and Mining IoT Mesh Without Cellular Backhaul \(/articles/memory-native-protocol/maritime-iot-mesh\)](/articles/memory-native-protocol/maritime-iot-mesh).
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- [Delay-Tolerant and Interplanetary Autonomy: Carrying Authority When There Is No Link Home \(/articles/memory-native-protocol/disconnected-and-interplanetary\)](/articles/memory-native-protocol/disconnected-and-interplanetary).

## **APPLICATIONS · SPECIFIC**

- [Starlink Alternative for Governed Mesh Routing: Why Satellite Handover Authority Stays Terrestrial \(/articles/memory-native-protocol/starlink\)](/articles/memory-native-protocol/starlink).
- [Zigbee vs Governed IoT Messaging: Why the Mesh Routes Frames but Carries No Authority \(/articles/memory-native-protocol/zigbee\)](/articles/memory-native-protocol/zigbee).
- [Does Matter Let Governance Travel With the Message? \(/articles/memory-native-protocol/matter\)](/articles/memory-native-protocol/matter).
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- [LoRaWAN Alternative for Governed IoT: Memory-Native Messages vs Passive Payloads \(/articles/memory-native-protocol/lorawan\)](/articles/memory-native-protocol/lorawan).
- [Beyond the Tailscale Coordination Server: Governed Mesh Networking Where Authority Travels With the Packet \(/articles/memory-native-protocol/tailscale\)](/articles/memory-native-protocol/tailscale).

- [QUIC vs Content-Scoped Authority: A Memory-Native Protocol Layer Above QUIC \(/articles/memory-native-protocol/quic-protocol\)](/articles/memory-native-protocol/quic-protocol).
- [MQTT vs Memory-Native Protocol: Where IoT Messaging Authority Should Live \(/articles/memory-native-protocol/mqtt\)](/articles/memory-native-protocol/mqtt).
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[Memory-Native Protocol overview → \(/memory-native-protocol\)](/memory-native-protocol).