

Physical Reality as Hypermedia

A proposal for an open, persistent, and decentralised layerover physical reality — neutral by design, owned by no one, available to everyone.

Adam Paigge

Co-Founder, Supernova Labs

adam@supernovalabs.co.uk

ABSTRACT

This paper proposes a mechanism for turning physical reality into hypermedia — a persistent, addressable, and linkable layer over the physical world that survives any single organisation failing, requires no new runtime for users to adopt, and is neutral by design rather than by policy. The atomic unit of this system is the physical object with a cryptographic identity. The primitive is simpler than it sounds: a card you can hold, a node you can walk past, a chain that stores the content itself. What follows is a description of the problem this solves, the mechanism that solves it, and the structural properties that prevent it becoming the thing it is designed to replace.

1. The Problem

1.1 Digital experience does not outlive the platforms that serve it.

When CERN commissioned Tim Berners-Lee to solve the problem of institutional memory in 1989, the problem was precise: experts left, and their knowledge went

with them. The system he proposed — documents that could link to other documents, without a central authority, without permission — created something that has outlasted every organisation that contributed to it. The web is still here. Most of the companies that built on it are not.

Digital experience has not inherited this property. A game world requires a game server. An NFT requires a marketplace. An AR experience requires a platform. When the platform goes, the experience goes. When the company fails, the assets go with it. The user never really owned anything — they held a licence, contingent on continued service, revocable at any time.

This is not a new observation. But it has not yet produced a solution at the infrastructure level. Every attempt to build a persistent digital layer over reality has reproduced the same failure mode: a central runtime that someone has to install, a central world state that someone has to maintain, a central authority that someone has to trust. The capture happens not because the builders are malicious, but because the architecture requires it.

1.2 The metaverse problem is an architecture problem.

Every vision of a persistent digital layer over physical reality has assumed that the layer would be served from somewhere. A data centre. A cloud platform. A company's infrastructure. This assumption is so embedded it is rarely examined. Of course there is a server. Of course there is a company. Of course you need to install the app.

But consider what the web actually did. It did not require a server you had to trust. It required a protocol anyone could implement. Documents lived wherever their authors put them. Links worked regardless of whether the linked page's host was the same company as the linking page's host. The web had no centre because the protocol assumed no centre.

The web also failed, in time, to maintain that decentralisation at the application layer. The absence of three things in the original protocol — an identity layer, a payment layer, and a privacy layer — created vacuums that were filled by companies with their own interests. The surveillance advertising economy was not an accident. It was the inevitable result of building infrastructure that made human attention legible to machines without giving humans any structural means to control that legibility.

The question this paper asks is not simply how to build a decentralised layer over physical reality. It is how to build one that does not reproduce the failures of the web — that is neutral by design rather than by aspiration, that gives individuals structural control over their own data, and that is structurally resistant to capture by any single authority regardless of that authority's intentions.

How do you turn physical reality into hypermedia without building the infrastructure for its capture?

2. The Mechanism

2.1 The physical object as addressable node.

The web's atomic unit was the document with an address. Any document could be given a URL. Any URL could be linked to from any other document. The network of links became the index — no central catalogue required, because the structure emerged from the connections themselves.

The atomic unit of physical hypermedia is the object with a cryptographic identity. Not a document, but a thing — a card, a building, a street corner, a product. Any object can be given an address. Any address can be resolved to content stored on a distributed chain. The network of objects and the experiences attached to them becomes the map.

The mechanism is already in every pocket. NFC is in every modern phone. The camera is in every modern phone. The browser is in every modern phone. The only missing piece is a protocol that connects physical objects to persistent digital identities without routing everything through a company's servers — and without requiring the user to understand that the protocol exists.

2.2 Physical possession as ownership.

In every existing digital asset system, ownership is a database entry on someone's server. You own the asset because the platform says you own it. The moment that database goes away, the ownership claim goes with it.

In this system, ownership is physical. A card carries its own identity, its own provenance, and its own cryptographic proof of ownership. When you hold the card, you hold the asset. When you hand someone the card, ownership transfers. The distributed ledger is not the ownership record — it is the settlement layer, the seed of last resort, the place the system turns when it needs to resolve a dispute or resynchronise after a network partition. Daily operations require no chain interaction at all.

This is a base layer, not a legal system. For many asset classes — collectibles, game items, access tokens, identity credentials — possession as ownership is sufficient and correct. For regulated assets such as property deeds or vehicles, legal systems and registries will impose their own requirements on top of the protocol. The protocol does not override those systems. It provides the infrastructure layer beneath them, the same way the web provides infrastructure beneath banking systems that have their own compliance requirements.

2.3 The chain as distributed CDN.

The standard use of a distributed ledger is as a transaction record — a chain of ownership events. This protocol uses it differently. The ledger stores the assets themselves: the 3D models, the experience definitions, the contract logic. Not pointers to files on someone's server. The files. Permanently. Retrievable by anyone with access to the chain, regardless of whether any particular company is still operational.

This makes the ledger a CDN of last resort. Other layers — local mesh nodes, user devices, distributed caches — serve content faster and closer. The ledger is what the system falls back on when everything else is unavailable. It does not need to be fast. It needs to be permanent. Asset storage exists on a spectrum: card metadata is kilobytes, a 3D model is megabytes. The protocol handles this through tiering — small assets store directly on ledger, larger assets use content-addressed storage with the ledger holding the permanent hash and retrieval proof. The ledger holds enough that nothing can be made to disappear.

The protocol is ledger-agnostic by design. Any distributed ledger that provides permanent storage and verifiable ownership can serve as the settlement layer. Supernova Labs is developing Script — a new chain, not yet deployed — as a reference implementation optimised for these requirements. But the protocol does not require Script. Different deployments can settle on different chains. The protocol sits above the ledger the same way the web sits above TCP/IP.

2.4 The mesh as local infrastructure.

Between the chain and the user sits a layer of physical infrastructure: small, low-power nodes communicating via radio, forming a mesh network that operates independently of the internet. These nodes are not servers. They require no data centre, no static IP, no permission to deploy. A node placed at a physical location becomes, in the experiential sense, that location.

A node serves locally cached content to nearby users without requiring internet. It witnesses interactions and co-signs the resulting transactions with its own keypair, providing proof of physical presence that has no equivalent in purely digital systems. It propagates state changes across the mesh to the nearest internet-connected point for chain settlement when connectivity is available.

The degradation path is graceful by design. Internet available: content serves fast from distributed cache. Internet down, mesh up: the local node serves from its own cache. Mesh down: the user's card and device carry what they need. Everything down: the system resynchronises from chain when any connection returns. At no point does the experience require a specific company's server to be running.

Node discovery is neutral by architecture. Nodes broadcast their presence. Every node that hears the broadcast propagates it. The map is a live view of that gossip — no registration, no approval, no central directory. If a node is on the mesh and broadcasting, it is on the map. The protocol is the directory.

3. The Properties

3.1 No runtime to adopt.

Every previous attempt at a persistent digital layer over reality has required the user to adopt something new. A headset. An app. A browser plugin. A wallet. Each additional step between encounter and experience is a place people leave.

This system requires nothing the user does not already have. NFC is in their phone. The camera is in their phone. The browser is in their phone. The experience boots from a tap or a scan. The first encounter is immediate. The infrastructure is invisible. The web did not succeed because HTML was elegant — it succeeded because clicking a link was something anyone could do without understanding TCP/IP. The equivalent action here is picking up a card and tapping it to your phone.

3.2 No central authority.

Anyone can mint a card. Anyone can run a node. Any IP holder can put their content on chain. Any developer can build experiences on top of the protocol. There is no approval process, no platform fee to participate at the infrastructure level, no company that can revoke access to the protocol itself.

Card validity derives from cryptographic structure, not from any issuing authority's approval. A node cannot distinguish between a card minted by Supernova Labs and a card minted by anyone following the open spec — because at the protocol level there are no Supernova Labs cards. There are valid cards and invalid cards. The protocol does not know who issued a valid card. It cannot discriminate on that basis because it has no information on which to discriminate.

3.3 Neutral by design, not by policy.

Net neutrality as a regulatory principle failed because it was trying to impose a constraint on infrastructure already owned by companies with financial incentives to violate it. Policy can be lobbied away. The right place to implement neutrality is in the protocol design, before there are incumbents with the means and motive to resist it.

A conformant node must serve any valid request from any valid card without reference to the card's issuer, the asset's creator, the experience's publisher, or the content's subject matter. This is not a rule the node is expected to follow. It is a consequence of the node having no information on which to base discrimination. The neutrality is structural.

The same principle applies to discovery. The map is a view over public mesh data, not an editorial product. Every valid node on the mesh appears on the map. Ordering is by proximity. There is no promoted content, no paid placement, no algorithmic ranking that serves the platform's interests over the user's. The data is a commons and any application can build on it.

3.4 Privacy by architecture, not by policy.

The web had no privacy layer. It was designed for documents, not for people. The absence of privacy primitives at the protocol level created the conditions for the surveillance advertising economy almost inevitably. This protocol is being designed for a world where that failure is visible in retrospect. The privacy layer is in the spec from the start.

Nodes do not retain interaction logs beyond what the current transaction requires. Card interactions use selective disclosure — proving ownership without revealing the persistent identity that would enable cross-node correlation over time. An agent

operating on a user's behalf must declare its capabilities explicitly, scoped and signed by the user, validated by nodes. An agent that exceeds its declared scope is rejected at the protocol level.

This does not make surveillance impossible — physical interactions are observable and radio networks leak metadata. What it does is make surveillance structurally constrained and economically unattractive. The protocol does not provide the aggregation primitives that would make mass correlation cheap. The goal is a system where surveillance requires the same effort as physical surveillance, rather than the frictionless bulk collection that digital systems currently enable by default.

The goal is a device that mediates aggressively on the user's behalf. The outside world knows only what the user has explicitly chosen to share, under terms they have set, for a duration they have defined. If companies require access to user data, they pay for it on terms the user sets. That inversion — from platforms extracting value from human attention without recompense, to individuals setting the terms of access — is a consequence of building the privacy layer into the protocol from the start.

3.5 Ownership that survives organisational failure.

The card carries cryptographic proof of ownership. The chain carries the asset. The mesh carries the local experience. None of these require Supernova Labs to be operational. If this company ceases to exist tomorrow, every card already minted still works. Every asset on chain is still accessible. Every node already deployed still serves its local area.

This is not a feature. It is the foundational design constraint from which everything else follows. A system that requires a company to stay alive is not infrastructure. It is a service. Infrastructure outlives the organisations that build it.

3.6 Extensible to any asset class or IP.

The protocol is world-agnostic. A card that carries a game avatar uses the same mechanism as a card that carries a car's service history, a property deed, a concert ticket, or a physical product's authenticity record. The experience layer changes. The underlying protocol does not. This is not a game, not an NFT platform, not an AR application. It is the substrate on which any of those things can be built, with the guarantee that the substrate will not be captured by any single application of it.

4. The Stack

Physical layer — the NFC card

A standard NFC card — hotel keycard form factor, printable face, durable enough to survive years of handling — carries in approximately one kilobyte everything the protocol needs: a cryptographically signed asset identifier; the current owner's public key; mint provenance; ability and attribute data; current state; and a boot URL that launches the AR experience directly from a tap. The mint block is write-locked at manufacture. State and ownership are updateable only by authorised parties.

Physical possession is the primary ownership claim. The card is the key, the identity, and the experience trigger simultaneously.

Cards use secure element NFC chips where the private key never leaves the hardware, making cloning effectively impossible. If a card is lost or stolen, the chain's signed ownership record provides a recovery path: a user who can prove they hold the key that signed the last legitimate transfer can initiate a dispute through the ledger. Physical possession is primary in normal operation. Cryptographic proof is the backstop when physical possession is contested.

Network layer — the mesh

Low-power nodes communicate via radio, forming a mesh that operates independently of the internet. Each node carries a keypair, a local cache of assets relevant to its geographic area, and the ability to co-sign transactions that require proof of physical presence. Nodes are deployed by anyone who wants to participate — there is no Supernova Labs node that is more authoritative than any other. Node identity follows an open naming schema: any node that adopts it appears correctly on conformant map applications. No registration required. The spec is the onboarding process.

The cold start is honest: Supernova Labs deploys the first nodes, the same way CERN ran the first web server. What sustains the network beyond that — whether through local community incentives, commercial deployment by businesses that benefit from local presence, or mechanisms the open specification process surfaces — is a question the protocol leaves open by design. What the architecture ensures is that the incentive to participate is always aligned with providing genuine local value, because a node that serves no one has no reason to exist.

Settlement layer — the ledger

The ledger stores the assets themselves — not references to files on servers, but the files. It is the place the system goes when everything else fails. It does not need to be fast. It needs to be permanent and decentralised enough that no single authority can instruct it to remove content or favour particular participants.

Supernova Labs is developing Script — a new chain, not yet deployed, built as a reference implementation of the ledger layer this protocol requires. Script is designed from the start with the governance properties the protocol depends on: distributed control, no single point of authority, protocol changes requiring the consensus of the network. The protocol does not require Script. It requires a ledger that meets the spec.

Experience layer — WebAR

Experiences boot from NFC tap or QR scan directly into the device browser. No app install. No account creation. No wallet setup. The physical card is the tracking marker for the AR scene — a known physical size giving the rendering engine a scale and orientation reference without any additional hardware. The character or asset renders immediately. Ownership, wallet synchronisation, and chain settlement

happen in the background, invisibly — as they do when you tap a contactless card to pay for coffee. The technology disappears. The experience remains.

5. Prior Art and What Is Different

The ideas in this paper are not without precedent. Berners-Lee proposed documents linking to documents. The Bitcoin white paper proposed trustless transaction settlement without a central authority. IPFS proposed content-addressed storage. Meshtastic demonstrated that mesh networking is accessible at consumer hardware price points. Each of these solved part of the problem.

What is different here is the combination, and the constraint that drives it: the system must work for a person who knows nothing about any of these technologies, has no intention of learning, and is encountering it cold — in the street, at an event, because someone handed them a card. The complexity budget available at the point of first contact is effectively zero.

Every existing system that combines blockchain, AR, and physical objects has failed this test. The user has to install a wallet. The user has to understand gas fees. The user has to connect to a marketplace. The user has to create an account. Each step is a place the system becomes the technology rather than the experience. The technology has to disappear.

The prior art that matters most here is not technical. It is the original web proposal itself — not for its implementation, but for its structure. Berners-Lee named a specific, painful problem that existing people already had. He proposed the simplest possible mechanism. He described the properties that mechanism had. He showed what already existed and what needed to be built. He did not require anyone to adopt a new paradigm. He required only that they follow a simple spec. The reward for following the spec was that your documents became reachable from everywhere. The reward for following this spec is that your objects, your places, and your experiences become part of a persistent layer that outlives any company.

6. Current State of Work

The following components are built and working:

- A WebAR experience that boots from NFC tap, renders an animated avatar in physical space with on-screen gamepad controls — no app install, no account, no wallet.
- A wallet and financial interface (Supernova Pay) with NFT inventory, smart contract management, NFC scanning, and a live geonode map showing physically deployed mesh nodes across the North West of England.
- A physical card minting workflow using hotel keycard form factor and ID card printer, with multi-modal access: NFC tap, QR code, and card face as visual AR tracking marker.
- A mesh node deployment providing local infrastructure for location-based experiences, discoverable via gossip protocol with no central registration.

- Script — a new chain in development, not yet deployed, built to serve as a reference implementation of the ledger layer this protocol requires.

The connective tissue — the NFC-to-wallet ownership claim flow, the node co-signature protocol, the chain settlement layer, the open protocol specification — is the current work. The architecture is validated. The experience prototype exists. The founding infrastructure is in place.

What comes next is not invention. It is integration, specification, and the writing of an open protocol document that any developer can implement against without asking permission.

7. A Note on Naming

We have deliberately avoided the word metaverse in this paper. Not because the vision is smaller, but because the word has been captured. It now carries the weight of a specific corporate product category: a virtual space you inhabit wearing a headset, served from a data centre, owned by a platform company. That is not what this is.

What this is differs in kind. It can be a virtual space. But fundamentally it is a layer over the real one. It is not served from a data centre. It is distributed across a mesh and anchored in a chain. It is not owned by a platform company. It is common infrastructure — available to anyone who wants to build on it, outliving any organisation that contributes to it, neutral by design rather than by the goodwill of whoever happens to be running it this year.

The language of blockchain and NFTs is equally unsuitable — not because the concepts are wrong, but because both terms carry cultural weight that obscures rather than illuminates. The person who finds a card on a street does not need to know what a blockchain is. They need to tap their phone and see something happen. The infrastructure is beneath that experience the way TCP/IP is beneath a web page. Essential. Invisible.

Agents that can navigate this layer are coming regardless of what it is called. The question of whether those agents serve the people living inside the system or the organisations extracting value from them will be answered at the design stage — in the protocol specification, in the conformance requirements, in the decision to make certain things structurally impossible rather than merely against the rules. That window does not stay open. It closes when the infrastructure is built and the incumbents have a stake in keeping it the way it is.

The name that fits is the one this paper starts with. The web made documents addressable and linkable without central coordination. This makes the world addressable and linkable without central coordination. The word for the result is not metaverse. It is not Web3. It is not the spatial web.

The word for the result is just: what comes next.

built with love and determination, not by VC

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social.supernovalabs.co.uk / adam@supernovalabs.co.uk