

Modernizing Spatial Data Infrastructure with Decentralized Web Technologies and Protocols

In response to: CFC, OGC Spatial Data Infrastructure Modernization Project 2025-2026

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Proposing entity: Professor Taylor Oshan from the UMD Department of Geographical Sciences (current OGC member) is proposing to contribute recent and ongoing work from his research group and collaborators to envision and develop a [decentralized geospatial web](#). This work began in 2022 through a project called [the EASIER Data Initiative](#) with support from the [Filecoin Foundation for the Decentralized Web](#). These efforts are now continuing under the umbrella of the recently launched [Decentralized Geospatial Collaborative](#) in conjunction with [Astral](#) and other community partners.

Contribution overview: The advent of Web 2.0 has been especially impactful, enabling interactive, collaborative web applications. These range from volunteered geographic information (VGI) and public data portals to cloud-based analysis and next-generation location-based services like routing and augmented reality. However, a tendency toward centralizing data and control in order to more effectively monetize resources and human attention has elicited concerns about sustainability, ownership, equity, and privacy. Partly in response, a third iteration of the web—often termed “Web3”—has emerged. Leveraging technologies including consensus networks, blockchains, smart contracts, asymmetric key cryptography, and peer-to-peer networking, Web3 proponents typically advocate for a more distributed, user-centric internet, often called the *decentralized web*.

Within this context, we envision and have been working towards a distinctly [decentralized geospatial web](#) that offers compelling possibilities for next-generation spatial data infrastructure: streamlined verification and reduced fraud while enhancing privacy; verifiable geocomputation for transparent, trustworthy workflows; and peer-to-peer data management to improve storage sustainability and local data sovereignty. Through this work, we have been exploring a series of decentralized web technologies and protocols and how they can be adapted to the geospatial realm in order to complement the suite of already existing and successful geospatial web standards and technologies. We therefore propose the following potential contributions to demonstrate where SDI is headed, primarily concerning the topic of *Technology*, though these contributions may also inform *Governance* and *People*.

Contribution 1: Incorporating a decentralized data storage and dissemination layer

Challenges, barriers, & gaps: Data is being produced in exponential volumes with relatively few private entities assuming control and profitability through the maintenance of these resources,

which are often public goods produced by international NGOs, national agencies, and local governments. Decentralized web technologies and protocols, such as the [InterPlanetary File System \(IPFS\)](#) and [Filecoin](#) are offering alternative paradigms where individual users can participate in a network of storage providers and content distribution. Besides increasing equity, this paradigm can increase data accessibility by ensuring content availability and data authenticity by ensuring content integrity.

Technology: Our work in this area has focused on increasing interoperability between traditional geospatial systems and burgeoning decentralized systems and increasing discoverability of geospatial content on decentralized systems. We first created a Python library called ipfs-stac ([github](#), [intro](#), [updates](#), [more updates](#), [example](#)), which facilitates the onboarding, retrieval, and exploration of geospatial data stored on the decentralized web by integrating STAC (SpatioTemporal Asset Catalog) metadata with metadata from IPFS and Filecoin. By leveraging ipfs-stac, researchers and developers can efficiently obtain and disseminate Earth observation data and other geospatial datasets in a distributed and censorship-resistant manner on the decentralized web. We also developed a dashboard ([live demo](#), [github](#), [overview](#)) for geospatial data monitoring that provides real-time monitoring and visualization of geospatial data (such as Landsat) stored on the decentralized web. Using the ipfs-stac library, the dashboard integrates IPFS and Filecoin metadata tracking, allowing users to verify data provenance and integrity, and download and share data via IPFS. We have also prototyped a data structure, for performing spatial queries directly on IPFS using discrete global grid systems as spatial indices.

Contribution 2: Verifiable and interoperable geospatial data across the web

Challenges, barriers, & gaps: As more autonomous sensors and AI agents come online there is a growing need to prove that location-based data records are authentic and interoperable. This is paramount to many location-based services consuming geospatial data, yet it is often not possible to verify what entity created a record or to evaluate evidence to prove (with varying degrees of certainty) the validity of location records. This is especially important as the MRV (Measurement, Reporting, Verification) economy develops.

Technology: In response, we recently developed the Location Protocol ([Intro](#), [github](#)) to provide a common format for portable, signed records of spatial information — including coordinates, boundaries, imagery, and other geospatial data. It works across decentralized and conventional systems, enabling consistency, attribution, and verifiability. The protocol is intended for anyone working with geographic data in contexts that require interoperability, transparency, or trust. A Location Protocol record is a digitally signed, self-contained unit of spatial data — structured like a row in a geospatial database, but portable and cryptographically verifiable. This structure supports a wide range of use cases — from building location-based applications on smart contracts, to verifying where compute operations took place. Wherever location matters and trust is required, the protocol offers a common language to structure and verify spatial information. We are currently integrating support for the protocol in [Proofmode](#) and other project partners. Ongoing work also includes an SDK and API for creating and querying Location Protocol compliant records, as well as [verifiable geocomputation](#).